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U. S. DEPARTMENT OF AGRICULTURE.

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B. T. GALLOWAY, *Chief of Bureau.*

NATURAL VEGETATION AS AN INDICATOR OF THE CAPABILITIES OF LAND FOR CROP PRODUCTION IN THE GREAT PLAINS AREA.

BY

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Plant Breeding Investigations.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., October 11, 1910.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 201 of this Bureau the accompanying manuscript entitled "Natural Vegetation as an Indicator of the Capabilities of Land for Crop Production in the Great Plains Area," by Dr. H. L. Shantz, Physiologist, Alkali and Drought Resistant Plant Breeding Investigations, Bureau of Plant Industry.

Extensive tracts of land, including thousands of acres that are doubtless capable of producing crops, still remain unoccupied in the United States, especially west of the ninety-eighth meridian. In places where no attempts at tillage have yet been made the would-be settler or investor is often at a loss to know whether the land in view is adapted to a particular crop or even whether it has any agricultural value. In such places the character of the natural vegetation is usually studied as an index of its crop-producing possibilities, but mistakes are often made in using this indicator without sufficient consideration.

The object of the present paper is to show how the native plant cover can safely be used as a guide to probable crop production. As a result of investigations carried on during the past three years in the Great Plains area definite correlations have been determined between the different types of vegetation and the physical characteristics and crop possibilities of the land occupied by each type. Although most of the detailed investigations have been carried on in eastern Colorado, enough work has been done elsewhere to show that with comparatively little modification the results can be applied throughout the Great Plains area. When the correlations are worked out for a given region as carefully as has been done in the present instance, they should not only be useful as a means to land classification on a large scale, but they could be applied by farmers and other persons who have occasion to estimate the probable agricultural value of new land.

The author desires to acknowledge his indebtedness to Dr. L. J. Briggs, Physicist in Charge of the Physical Laboratory of the Bureau of Plant Industry, for much advice and assistance in the physical part of the investigations. In connection with the experimental work in the field Mr. E. C. Chilcott, Agriculturist in Charge of Dry-Land Agriculture Investigations, Bureau of Plant Industry, placed at the author's disposal the resources of the dry-land experiment farms in the Great Plains area. The Bureau of Soils has obligingly furnished chemical and mechanical analyses of numerous soil samples.

Respectfully,

G. Harold Powell,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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NATURAL VEGETATION AS AN INDICATOR OF THE CAPABILITIES OF LAND FOR CROP PRODUCTION IN THE GREAT PLAINS AREA.

INTRODUCTION.

Farmers and other persons who have occasion to examine new land in order to form a judgment of its agricultural value depend largely upon the natural vegetation, or plant covering, as an indicator of its crop-producing capabilities. But there are many possibilities of error in judging land upon this basis. Species that are closely related botanically and very similar in appearance may indicate quite different conditions of soil and climate. The popular names of plants are likely to cause confusion. Thus, the farmer who has learned in the Great Basin region that "greasewood" is an indicator of alkali land and that "sage brush" usually grows on land free from alkali will find, if he moves to southern Arizona or southeastern California, that the shrub there known as "greasewood" indicates absence of alkali, while the so-called "sage bushes" of that region grow on strongly alkali land. Furthermore, there is a general tendency to depend upon a single plant species as an indicator, while the investigations set forth in this bulletin show that the composition of the plant covering as a whole is a much more reliable basis for judging the crop-producing capabilities of land.

The chief object of the present paper is to show how these sources of error may be avoided and how new land may be classified readily and with reasonable accuracy on the basis of its natural vegetation. This paper is not a report of a land survey, but rather a discussion of methods which it is believed could be utilized to advantage in making such a survey, the methods being illustrated by application to a limited territory in the Great Plains area.

Too much emphasis can not be laid upon certain facts that have been clearly brought out in the course of these investigations: (1) Correlations between the natural plant cover and the crop-producing capabilities of land in a given area can be satisfactorily determined only after careful study of the different types of vegetation of the area in relation to their physical environments; (2) such correlations, determined for some particular region, will need to be modified to a greater or less extent before they can be applied in another region where the physical conditions are different. When, as a result of sufficient investigation, correlations of this nature are determined for a given area, it is believed that they will afford a basis for classifying the land of that area more readily and at least as accurately as by any other known method.

In order to test and perfect the methods here described it was necessary to make a detailed study of the vegetation of some particular area in relation to the physical conditions, checking the observations by the study of such examples of actual crop production as exist on the different types of land. It was decided to begin work in the Great Plains area that lies between the ninety-eighth meridian and the Rocky Mountains, for this region contains the largest body of land in the United States having possible agricultural value on which the native plant covering is still undisturbed. A further advantage is the comparative uniformity of the climate throughout the area from the Canadian boundary on the north to the "Panhandle" of Texas on the south. The investigations thus far have been made chiefly in a portion of eastern Colorado, a region which is considered representative because of its central position and because its climatic conditions are almost as extreme as anywhere in the Great Plains. But enough data have been gathered in other portions of the Great Plains to make it fairly certain that with comparatively little modification the correlations shown will hold good throughout the area.

The work so far accomplished has brought out clearly that in this area the general conditions, whether favorable or unfavorable to crop production, are indicated by the character of the native plant cover. Land which bears a pure short-grass cover was found to be supplied with water in the surface foot or two of soil only, and usually even to that depth for but a brief period during spring and early summer. Land with a uniform cover of tall grasses was found to be supplied with water to a much greater depth and to offer conditions favorable for plant growth during a much longer season. As a connecting link between these two conditions a short-grass cover which supports a scattered growth of taller plants was found to indicate intermediate conditions as regards water supply.

The areas of greatest agricultural value one year with another are those marked by the presence of the wire-grass vegetation (p. 48). Of almost equal value are the areas characterized by those phases of the grama–buffalo-grass vegetation which are distinguished by the presence of a considerable quantity of Psoralea (p. 46) or of wire-grass (p. 47). Bunch-grass land (p. 54) is best for crops during especially dry years, but is relatively the least productive during favorable years. Typical short-grass land (grama–buffalo-grass association p. 24) produces more than any other type during wet years, but is first to fail in time of drought. Areas characterized by certain other types of vegetation (p. 60) were found to be unfit for agricultural purposes.

GENERAL CONSIDERATIONS ON THE USE OF VEGETATION AS AN INDICATOR.

DIFFICULTY OF CORRELATING VEGETATION WITH ANY SINGLE FACTOR OF THE ENVIRONMENT.

The great difficulty of correlating vegetation with any single factor is shown by the vast difference of opinion among botanists as to which factors are of the greatest importance in controlling plant distribution.

Correlations with the physical or the chemical nature of the soil have often been successfully applied for a limited area, but without exception these correlations have failed to apply when extended to wider areas. The results of numerous attempts seem to prove that a strict correlation of vegetation with the physical or chemical nature of the soil is possible only when all other conditions of the habitat are comparatively uniform. When the climatic conditions and the physical condition (texture, water content, etc.) of the soil are uniform we should be able to correlate variation in the vegetation with differences in the chemical nature of the soil; on the other hand, when the climatic conditions and the chemical composition of the soil are uniform, the differences observed in the vegetation are probably due to inequalities in the physical nature of the soil. Variations, either physical or chemical, are of greatest importance when they approach the limit of favorable conditions. A correlation between vegetation and either the chemical or physical nature of the soil can be expected to apply only over a limited area where the other conditions are practically uniform. As soon as we move from one region to another the correlation between vegetation and soil type is at once broken down.[a] In the Great Plains region this is very clearly brought out by the following examples:

In eastern Colorado short-grass vegetation is correlated with a loam soil, wire-grass with sandy loam soil, and bunch-grass with sand soil. Here, under conditions of practically uniform rainfall, evaporation, etc., we have a close correlation between the vegetation and the soil types.

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[a] Thurmann, Julius. Essai de Phytostatique, 1849, p. 403. Warming, Eugenius. Ecology of Plants, 1909, pp. 69–70.

Again, in eastern Colorado, with a rainfall of from 15 to 18 inches, loam soil is covered with a comparatively pure short-grass cover; in west-central Kansas, with a rainfall of from 22 to 24 inches, loam soil is characterized by wire-grass vegetation; while in eastern Kansas, with a rainfall of from 26 to 30 inches, bunch-grass occurs on this type of soil. Here, under comparatively uniform soil conditions, a rather close correlation can be established between rainfall and vegetation.

But under practically uniform soil conditions the pure short-grass formation is found in the "Panhandle" of Texas, where the average annual rainfall is about 21 inches, and in eastern Colorado, with an average annual rainfall of 17 inches, while in Montana a comparable type of pure short-grass vegetation is found where the average annual rainfall is only 14 inches. Similar observations could be made upon any other type of vegetation which extends throughout the region. A correlation with amount of rainfall alone is not possible; for, if we judge from the vegetation, a rainfall of 14 inches in Montana is equivalent to a rainfall of 21 inches in Texas. Lines drawn from north to south showing conditions equally favorable for plant growth, as we pass southward, cross lines of increasingly higher annual rainfall. It is clear in this case that factors other than the amount of annual rainfall must enter into the correlation,[a] since on a uniform soil differences in the amount of annual rainfall produce no changes in the type of vegetation.

To attempt a close correlation of plant associations with temperature alone is equally difficult. The short-grass and prairie-grass formations each range from the Lower Austral through the Upper Austral and into the Transitional life zone, taking these life zones as defined by Merriam.[b] It is obvious that in the region here considered water is the chief limiting factor and temperature is of comparatively minor importance in influencing plant distribution.

From the cases above mentioned we can see that neither the rainfall nor the soil type alone determines what type of vegetation will be found in any given area; for of the first two correlations discussed in which only these factors are primarily concerned, either may be cited to disprove the other. Many similar examples could be given, but these will serve to show how utterly impossible it is to make a close correlation between a type of vegetation and any single factor of the plant environment if in so doing we neglect other factors.

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[a] See Powell, J. W., "Lands of the Arid Region," 1879, p. 51, and Johnson, W. D., "The High Plains and Their Utilization," Twenty-First Annual Report of the United States Geological Survey, pt. 4, 1901, p. 678; also Briggs, L. J., and Belz, J. O., "Dry Farming in Relation to Rainfall and Evaporation," Bulletin 188, Bureau of Plant Industry, United States Department of Agriculture, 1910, pp. 20–22.

[b] Merriam, C. Hart. Laws of Temperature Control of Geographical Distribution of Terrestrial Animals and Plants. National Geographic Magazine, vol. 6, 1895, pl. 14.

In most of the investigations that have been made in this field the investigators have not fully considered the effect of variations in factors other than the one with which they sought to establish correlations. If they have failed to make their case it is largely because their generalizations from the data in hand were too broad. The vegetation is undoubtedly of value as an indicator of different soil types in regions where climatic conditions are uniform, but correlations established in one region must not be applied to other regions until they have been thoroughly tested and found to hold true.

CORRELATION WITH SOIL MOISTURE.

One of the most successful correlations yet attempted is that between plant associations and water content of the soil. This correlation, set forth in 1823 by Schouw,[a] has been accepted and modified by leading ecologists[b] and has proved one of the most useful generalizations in the study of vegetation. The great ecological divisions of the earth's surface—ocean, forest, grass land, and desert—are largely expressions of this water relation.

Correlations of vegetation with soil type are, in the great majority of cases, really correlations with soil-water content, soil texture being chiefly important to the plant through its influence upon available moisture. One of the greatest difficulties in the local application of this correlation has been the fact that the water relations of the different types of soils have been defined only in a very general way. Because of this fact very little of the water-content work that has been published is of practical value. Determinations are almost worthless unless checked carefully by some such standard as "nonavailable moisture" or "moisture equivalent" (p. 18). As has been often pointed out, the moisture relations of different soils are so variable that a mere statement of per cent of water means almost nothing. Clay, for example, is as dry as dust to the plant when it contains 18 per cent of water, while most sands are very nearly saturated with 18 per cent of water.

A slight variation in the quantity of available soil moisture would probably have less effect on the character of the vegetation than would a difference in the season of the year or in the length of time during which available water is present. Determinations of water content should be made throughout the entire growing season in order to be of much value in interpreting plant distribution. Observations should also be made during the periods when vegetation is in a resting condition, to determine whether or not this state of dormancy has been produced by lack of water. On the Plains, for example, the water content of the soil in spring and early summer is often sufficient to support a mesophytic[a] type of vegetation, but the fact that the supply is often entirely inadequate during the late summer, autumn, and winter is enough to exclude plants which require considerable water for a longer period, although it may suffice for a short-season grass, which can lie dormant without injury during the remainder of the year.

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[a] See Schouw, J. F., "Grundzüge einer Allgemeinen Pflanzengeographie."

[b] See Warming, Eugenius, "Plantesamfund. Grundtræk af den ökologiske Plantegeografi," 1895, and "Ecology of Plants," 1909: Schimper, A. F. W., "Pflanzengeographie auf Physiologischer Grundlage," 1898; and Clements, F. E., "Research Methods in Ecology," 1905.

Difficult as is the attempt to establish a correlation between vegetation and any one factor of the environment which will hold good throughout an extensive region, it is possible to make such a correlation within a limited area where there is more or less uniformity in regard to factors other than the one with which the correlation is attempted.[b]

CORRELATION OF VEGETATION WITH CROP PRODUCTION.

In considering the correlation of natural vegetation with crop production many of the difficulties experienced in correlating vegetation with the physical environment are eliminated. Broadly speaking, the native plants obey the same physiological rules as do cultivated plants having the same general requirements with respect to moisture, heat, and light. Hence, it should be comparatively easy to infer from the differences in the native vegetation produced by differences in the physical environment what would be the effect of similar differences upon cultivated plants.

It is reasonable to believe that correlations can be established between the native vegetation and the possibilities of crop production on a given type of land,[c] for in the end plant growth is the measure of the effect of all conditions which are favorable or unfavorable for agriculture. Methods of soil management, the application of fertilizers, and all such farm practices are tested by the size of the crop produced. Since plant growth is the ultimate measure, it would seem that the character, growth, and condition of the native vegetation must be the best possible indication of a favorable or unfavorable environment on land where crops have not yet been produced.

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[a] Mesophytic plants are those which thrive neither in a very wet nor a very dry soil, but are limited to a moist soil. Practically all cultivated plants are mesophytes.

[b] Warming, Eugenius. Ecology of Plants, 1909, p. 70.

[c] Hilgard, E. W. Soils, 1906, p. 314.

We must also recognize that so far as the conditions of growth are concerned many of our native plants are far more exacting than are the cultivated-crop plants. The distribution of most of the native plants is far more limited than that of cultivated plants, and this is partly due to the fact that native plants are more specialized in their requirements as to habitat. Even though the immediate reason for their limited distribution may be that they are unable to compete successfully in the struggle for existence with other plants with which they come into competition outside of the areas where they find the conditions most favorable for their growth, the fact remains that most of them have a more circumscribed habitat than any of the common cultivated crops. This should make it all the safer to state that a certain cultivated plant will find within the range of a certain native plant association the optimum conditions for growth and crop production.

By studying the vegetation of a region from a physiological point of view the conditions for growth indicated by each association can be brought out with sufficient clearness to enable us to predict with a fair degree of confidence the probable success or failure of a particular agricultural crop on land covered by a particular plant association. The final test must, of course, be the success or failure of the crop when grown on the land in question. Correlations based on the condition of crops during an exceptionally favorable season are of value only as long as such conditions are maintained. In order to be really useful the correlations must be made during seasons when the climatic conditions are normal for the region. As the ultimate criterion the yield should be used rather than the condition of the crop at any time previous to harvest.

ENTIRE PLANT COVER A BETTER INDICATOR THAN ANY SINGLE SPECIES.

The entire vegetation, or plant cover as a whole, is a more reliable indicator of conditions than the presence or the condition of any single species. Vegetation is not only an expression of the present conditions, but is to some extent a record of conditions that have obtained during a period of many years. This record is not likely to be greatly altered by a year or two in which conditions depart from the normal. It is this relative stability which makes the vegetation so reliable an index on the Great Plains. Sometimes the rainfall during a series of years is so much above the normal as to give rise to a popular impression that the region has become as humid as eastern Kansas and Nebraska. The character of the native vegetation, however, stamps this as an area where conditions of excessive moisture are never maintained during long periods, or at least during a sufficiently long period to enable mesophytic plants to establish themselves.

In the plant cover as a whole we have a record which is as stable as the most stable single species and as sensitive as the most exacting plant. Any change in the physical conditions produces an immediate effect on the growth of the year, and, to a less extent, on the perennial growth as well. Notwithstanding this, one can read from the vegetation the record of the average and not of the exceptional years. If rightly interpreted the vegetation offers a record far more valuable and far more complete than any series of meteorological observations now available. In the present work we are concerned with soil and atmospheric studies only in so far as they aid in the determination of a direct correlation between native vegetation and crop production.

The effects of mowing, grazing, fires, etc., must be taken into full account in determining correlations. The vegetation which in one place indicates a heavy soil may in another indicate a lighter soil where fires occur occasionally. Vegetation which in one case indicates a rather heavy type of soil with light rainfall may in another case indicate the same type of soil and a heavier rainfall if the land is exposed to excessive grazing. It is necessary, therefore, to determine very carefully the conditions under which particular types of vegetation have developed before attempting to correlate them with the possibilities of crop production.

METHODS.

In using the native vegetation as an indicator the first step is to make a thorough study of the plant cover in order to become familiar with the more important species and the plant associations which they form. The dominant associations as well as the less important ones should be clearly recognized and defined. The definition of the various associations is best accomplished by the use of modern ecological methods. The method found most valuable in the present work was that known as the quadrat method.[a]

Where exact records of the structure of the plant cover were desired, a quadrat of 1 yard (or 1 meter) was mapped in detail on cross-section paper (fig. 1). These maps were most useful as records of typical portions of plant associations. The areas occupied by the different plant associations were mapped by means of colored pencils on blank township maps on a scale of 1 inch to the mile. When once the plant associations were clearly distinguished, the geographical distribution of each association could be readily recorded by this method.

In addition to the work mentioned above there is the much more difficult task of determining what factors have brought about the groupings of plants into these definite associations. Important as are the factors of reproduction, dissemination, and establishment, or of invasion and succession in the early stages of the associations, it is largely in the physical inequality of the plant habitat that we find the reason for the present distribution of vegetation in the region under consideration.

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[a] See Clements, F. E., "Research Methods in Ecology," 1905, p. 161.

In studying the factors which have contributed to the origin of a particular association we have then to take into account, first of all, the physical conditions under which the association thrives. In doing this for the region here discussed all available data have been used. Air-temperature and rainfall records were easily obtained; an accurate record of evaporation, saturation deficit, soil moisture, and soil temperature is taken[a] at 11 different stations on the Great Plains. These more general records have been supplemented by many simultaneous comparative observations made by the writer in the different plant associations.

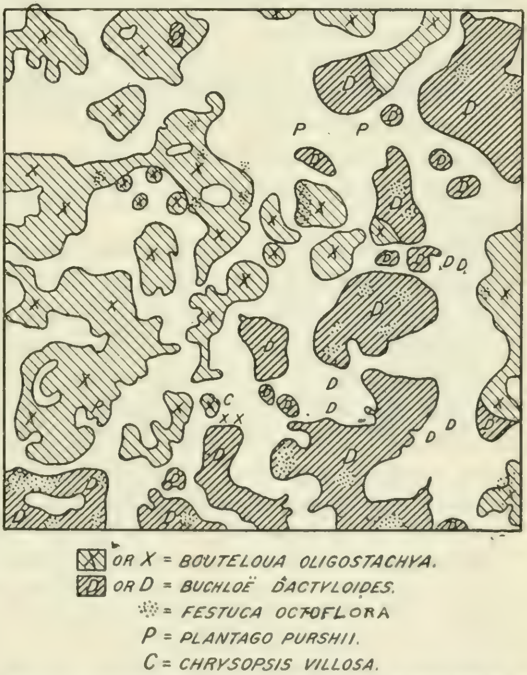

FIG. 1.—A one-meter quadrat, from the grama-buffalo-grass association (short-grass formation) at the Dry-Land Agriculture Experiment Farm, Akron, Colo.

Water is the chief "limiting factor" for plant growth in the Great Plains area. It was therefore necessary to know the amount present in the soil during the period covered by these investigations. A series of determinations made at a carefully chosen base station twice a day throughout the season gave the most valuable data that were obtained, but it was also found desirable to make occasional determinations of soil moisture at other points. These occasional determinations were made both at the same time in different plant associations and at different times in the same association, the choice of the location and time depending upon the weather and the condition of the vegetation.

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[a] Under the direction of Dr. L. J. Briggs, of the Physical Laboratory of the Bureau of Plant Industry.

The soil moisture was actually determined in percentages of water to dry weight of the soil, but in this shape the data are of little value for comparing the behavior of plants growing on soils of different texture. It was found necessary, in order to make such comparison, to reduce the data to some definite standard. The best standards for a comparison of moisture conditions in different types of soil in relation to plant growth and behavior were found to be the moisture equivalent and the nonavailable moisture.[a]

The rate of penetration is of such importance in influencing the amount of water in the soil that it was considered essential to make careful measurements of the time required for a given amount of water to enter the soil, and also of the quantity of water taken up by the soil during a rainfall of known amount.

Chemical and mechanical analyses of soils were necessary as a check upon the correlations between soil moisture and plant distribution. The analyses required were obligingly furnished by the Bureau of Soils.

Plant migrations, invasions, and successions are of great importance in considering the origin and present structure of plant associations. In order fully to understand each particular association, how it has originated and what conditions it indicates, it was necessary to go somewhat in detail into the subject of competition between different species. In this connection a study of the root systems of the different species, as well as of the effects produced on the vegetation by fires, and by mowing, grazing, and other human and animal agencies, was found to be indispensable.

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[a] The moisture equivalent is the amount of water left in the soil when saturated soil has been subjected to a force of 1,000 times gravity. (See Briggs, L. J., and McLane, J. W., "The Moisture Equivalents of Soils," Bulletin 45, Bureau of Soils, U. S. Dept. of Agriculture, 1907.)

The nonavailable moisture is the amount of water which remains in the soil after the plant has wilted as a result of insufficient moisture. (See Sachs, Julius, "Bericht über die physiologische Thätigkeit an der Versuchstation in Tharandt," Landw. Versuchs-Stationen, 1859, vol. 1, p. 235.) The nonavailable moisture, expressed in percentages, is here used to signify the maximum percentage of water in the soil which can not be utilized by the plant, or what might be called the point of nonavailable maximum. When the amount recorded is less than this maximum nonavailable it is referred to as below the nonavailable. In figures 5 to 10, inclusive, the nonavailable maximum is represented by the zero line. (For a statement of the relation of moisture equivalent to nonavailable moisture see Table XII, p. 78.)

Hygroscopic coefficient (Hilgard, E. W., Soils, 1906, p. 196) is more difficult to determine and more easily affected by fluctuations in temperature or humidity, and on this account is not as useful as the other determinations here mentioned.

In studying a succession[a] it is necessary, first of all, to have a comprehensive knowledge of the established vegetation and to supplement this by a careful study of associations occupying adjacent areas which might influence its structure. One should clearly recognize the great primary successions which have led to the establishment of the existing vegetation, since these must be taken into account in considering the indicator value of any particular association. On the Great Plains it was necessary to extend observations over a wide area, for no correct idea of succession can be obtained unless this study has been sufficiently extended to enable one to secure a view of practically the whole field of plant migration which is directly concerned in shaping the particular association under observation.

PLANT FORMATIONS AND ASSOCIATIONS IN EASTERN COLORADO.

SCOPE OF THE INVESTIGATIONS.

While this work has been carried on to some extent in all the States in the Great Plains region, the more detailed investigations have been confined to Washington and Yuma counties, in eastern Colorado. The results are not expected to apply in their smaller details except in the region lying north of the Arkansas River and south of the South Platte, in eastern Colorado. Correlations must be somewhat modified in passing beyond the limits of this area, but with slight modifications they will probably hold good in a general way for most of the Great Plains region.

The survey of the vegetation of this region was undertaken by the use of methods outlined by Clements ("Research Methods in Ecology," 1905), somewhat modified and extended to suit the special conditions under which the work was carried on.

CLASSIFICATION OF VEGETATION TYPES.

In the classification of the plant associations no attention is paid to those associations found along the creek banks or in marsh and alkali flats, for the reason that the work is intended primarily to deal only with the vegetation of that portion of the area which receives its water supply directly from precipitation.

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[a] Succession is the phenomenon of replacement of one type of plant cover by another. This change in vegetation is brought about in many ways. The plants themselves, by gradually changing the conditions, are often the most important factor in bringing about the change. Successions have been classified as to their initial cause as primary (those dealing with the revegetation of newly formed land) and secondary (those brought about by the destruction or removal of the original vegetation). Secondary successions occur most commonly as the result of human agency. (See Clements, F. E., "Research Methods in Ecology," 1905, p. 239.)

The more important plant groups which constitute the vegetation of eastern Colorado and the more important species of each group are here listed in such a way as to indicate the structural and historical relationships of the groups.

Classification of vegetation types.

Formation.[a]	Association.[b]	Society.[c]	Dominant species.
Lichen			Rinodina oreina. Lecanora calcarea. Parmelia conspersa.
Short-grass			Bouteloua oligostachya. Buchloë dactyloides.
	Gutierrezia-Artemisia		Gutierrezia sarothrae. Artemisia frigida. Bouteloua oligostachya.
	Grama-buffalo grass		Bouteloua oligostachya. Buchloë dactyloides.
		Psoralea tenuiflora	Bouteloua oligostachya. Buchloë dactyloides. Psoralea tenuiflora.
		Aristida longiseta	Bouteloua oligostachya. Buchloë dactyloides. Aristida longiseta.
	Wire-grass		Bouteloua oligostachya. Aristida longiseta. Psoralea tenuiflora.
Prairie-grass			([d])
	Bunch-grass		Andropogon scoparius.
	Sand-hills mixed		Bouteloua hirsuta. Andropogon hallii. Calamovilfa longifolia. Artemisia filifolia.
	Blow-out		Redfieldia flexuosa. Muhlenbergia pungens. Psoralea lanceolata.

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[a] The plant formation is the most important vegetation type, and signifies a group of plants which have the same general growth form, or appearance. While different portions may differ widely as to the species which form the plant cover, they are similar in general outward appearance and indicate more or less uniform environmental conditions. (See Warming, E., Ecology of Plants, 1909, p. 139; and Clements, F. E., Research Methods in Ecology, 1905, p. 292.)

[b] The term "plant association" is used here in place of the technical term "consocies" (Clements, Research Methods in Ecology, 1905, p. 295). The association is usually more uniform as to species than the formation and occurs only as a major division within the formation (Warming, Ecology of Plants, 1909, p. 144).

[c] A plant society is a phase or aspect of an association characterized by some one or a few predominant species.

[d] Since only the western portion of this formation is considered, the dominant species for the entire formation can not be given.

In addition to the associations listed under the short-grass formation there are two other associations which are of great importance when considering the vegetation of the Great Plains area as a whole but which occupy a very small area in eastern Colorado. They are omitted from the above classification because it is difficult to show the relationship of the important associations when these are also listed. These associations, relatively of small importance in eastern Colorado, are as follows:

Supplementary classification of vegetation types.

Formation.	Association.	Dominant species.
Short-grass		Bouteloua oligostachya. Buchloë dactyloides.
	Grama grass	Bouteloua oligostachya.
	Wheat-grass	Bouteloua oligostachya. Buchloë dactyloides. Agropyron smithii.

A detailed botanical description of the formations and associations would be out of place in the present publication, but it seems desirable to connect these associations with those described by Pound (Roscoe) and Clements (F. E.) in the "Phytogeography of Nebraska," 1900. It must be remembered that the Nebraska work was pioneer work, and that while it was most carefully and thoroughly done, a fuller knowledge of the development of the vegetation of the plains has made it undesirable to follow closely the grouping therein set forth. The present classification corresponds only in a general way with that adopted by Pound and Clements.

As understood by the writer, the short-grass and prairie-grass formations cover practically all of the area east of the mountains and west of the Mississippi Valley forest area.

The short-grass formation in the writer's conception includes the following formations recognized by Pound and Clements, which are discussed in the "Phytogeography of Nebraska," on the pages indicated: Buffalo-grass formation, 350; Stipa formation, 381; Agropyron formation, 383; peppergrass-cactus formation, 386; beard-grass formation, 361. The Agropyron formation of Pound and Clements corresponds to the writer's wheat-grass association, and their buffalo-grass and peppergrass-cactus formation corresponds to the writer's grama–buffalo-grass association. The beard-grass formation of the "Phytogeography of Nebraska" corresponds to the wire-grass association of the present publication, and is placed by the writer in the short-grass formation because of the preponderance of grasses of the short-grass type, although it is clearly an intermediate association between the two great formations.

The prairie-grass formation, as described by the writer, is also much more comprehensive than the formation of the same name as understood by Pound and Clements (p. 348). It includes the writer's bunch-grass association, which corresponds to a part of the bluestem type of the bunch-grass formation (Pound and Clements, p. 355), and the writer's sand-hills mixed association, which also corresponds to a part of the bluestem type of the bunch-grass formation (Pound and Clements, p. 355), and to the *Artemisia filifolia* formation (Pound and Clements, p. 372). The blow-out association of the writer corresponds to the blow-out formation of Pound and Clements (p. 365), and in the present publication is included in the prairie-grass formation, because it invariably passes directly into one of the associations of that formation. The *Artemisia filifolia* formation of Pound and Clements (p. 372) is included in the sand-hills mixed association of the writer because of the fact that this species of Artemisia so generally occurs in this association. The bunch-grass association, as it occurs in eastern Colorado, is a much more nearly closed[a] association than in portions of Nebraska, and what is said in this paper relative to the conditions indicated by this type of vegetation applies only when the ground is well covered and the vegetation is of the closed type rather than of the open type so often met with on the more unstable sand hills of Nebraska.

The great prairie-grass formation includes many associations which flourish east of the Great Plains area and are not here considered. The *Artemisia tridentata* formation, one of the principal formations occurring in the mountain region west of the Great Plains area, is found in places within the latter area, but does not belong to either the prairie-grass or the short-grass formations.

GEOGRAPHICAL DISTRIBUTION OF THE FORMATIONS.

THE LICHEN FORMATION.

Plants of the lichen formation occur wherever there are rock outcrops or where the soil is covered or partially covered with rock fragments. Naturally they are most important near the mountains.

THE SHORT-GRASS FORMATION.

Occupying the greater part of the Great Plains area, the short-grass formation in the United States extends from southern Texas to northern Montana and Dakota, and from the Rocky Mountains eastward to where it meets the prairie-grass formation in central Texas, Nebraska, and the Dakotas. It is limited on the east by the increasing moisture, which enables the deeper rooted, taller, and more mesophytic prairie-grass species to kill out the short grasses by competition. On the west it is limited by the mountain ranges with their woody vegetation, and in the intermountain areas by the xerophytic conditions which are the direct result of winter rains and dry summers. This condition of almost exclusively winter rainfall is entirely unfavorable for the shallow-rooted short grasses, but is congenial to a scattered growth of deep-rooted plants, such as makes up the great *Artemisia tridentata* formation of the intermountain areas. Within the short-grass formation there are several well-marked associations.

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[a] Reference is here made to an association or formation in which the ground is closely covered with plants. Technically a closed formation is one into which other plants can not migrate without displacing some of those already established.

The Gutierrezia-Artemisia association must be regarded as an early stage in the short-grass formation and often represents a transition from the lichen formation. It is an important association near the mountains, notably in northeastern New Mexico and southeastern Colorado, but it also occupies extensive areas in other portions of the Great Plains, especially in places where there are outcrops of only partly disintegrated rock.

The grama-grass association is best developed in the northern Great Plains, especially in Montana and extending south along the mountain front to central Colorado.[a] It is not an important association in eastern Colorado.

The grama–buffalo-grass association is the most extensive subdivision of the short-grass formation. It predominates over the whole central portion of the Great Plains area and extends far south into Texas. In the southwestern portion it is somewhat modified by the occurrence of *Muhlenbergia gracillima* Torr., and upon further investigation this portion may prove to belong to another association.

The wheat-grass association is best developed in South Dakota, west of the Missouri River, on the adobe soil derived from the Fort Pierre shale, but it also occurs in detached areas both north and south of this region.

The wire-grass association is found chiefly in that portion of the short-grass formation which is adjacent to the prairie-grass formation. In eastern Colorado, where it covers a considerable area, it usually borders the sand hills.

THE PRAIRIE-GRASS FORMATION.

Most extensively developed in the eastern part of the Great Plains, the prairie-grass formation is limited on the east by the conditions favorable to the growth of trees with which the plants of this formation can not directly compete. The burning of the prairie grasses when they are dry is very detrimental to tree growth, and since these fires are often started by lightning the migration of trees into grassland areas, even before the advent of man, must have been accomplished with great difficulty. On this account the prairie grasses were able to occupy a great deal of land in regions where the moisture conditions were favorable to tree growth. While limited on the east by plant competition, this formation is limited on the west by the low water content of the soil. Although the physical environment in the prairie-grass formation is favorable to the short grasses, they are shut out by direct competition with the taller and deeper rooted species. On the other hand, as we pass westward the prairie grasses are gradually shut out by insufficient water supply and the short grasses are left in possession. Within the area of the present investigations the prairie-grass formation is represented only by the bunch-grass association, the sand-hills mixed association, and the blow-out association.

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[a] Shantz, H. L. A Study of the Vegetation of the Mesa Region East of Pikes Peak: The Bouteloua Formation. Botanical Gazette, 1906, vol. 42, pp. 16–17 and 179–207.

The bunch-grass association embraces the type of native vegetation that, according to early reports, originally occupied eastern Kansas.[a] It extends northward in a somewhat modified form into the Dakotas and southward in a typical form far into Texas. It pushes westward on sandy land into the midst of the short-grass formation, occupying large areas in western Nebraska and Kansas, eastern Colorado, and northern Texas.

The sand-hills mixed association occupies extensive areas in sand-hill regions, and has practically the same distribution as the bunch-grass on the sandy lands of western Kansas and Nebraska, eastern Colorado, and northern Texas.

The blow-out association represents the earliest stages of the sand-hills mixed association and is highly developed only in the regions of moving sand.

ASSOCIATIONS IN EASTERN COLORADO WHICH INDICATE LAND OF AGRICULTURAL IMPORTANCE.

THE GRAMA–BUFFALO-GRASS ASSOCIATION.

General Appearance.

Representing the most typical form of the short-grass formation, the grama–buffalo-grass association presents an appearance of extreme monotony. The plant cover is uniform and velvet-like; in some places it covers practically the whole surface of the ground; but in other places it is broken up into alternating spaces of open ground and dense, mat-like cover (fig. 1). The amount of soil surface covered varies from as low as 10 per cent to as high as 90 per cent. The plant growth is usually closest where there is a mixture of buffalo grass and grama grass. Where grama grass largely predominates the vegetation is often of the open-mat type. (See p. 44.) In the pure form of this association there are practically no plants which rise above the short-grass layer. Reference to Plate I, figure 1, will give the best idea of the general appearance of this type of vegetation.

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[a] Hall, Elihu. Notes on Some Features of the Flora of Eastern Kansas. American Journal of Science and Arts, vol. 50, 1870, pp. 34, 35.

Botanical Composition.[a]

In eastern Colorado the short-grass vegetation is composed almost entirely of two species, grama grass (*Bouteloua oligostachya* (Nutt.) Torr., fig. 2) and buffalo grass (*Buchloë dactyloides* (Nutt.) Engelm., fig. 3). It is not an uncommon thing to find areas (Pl. I, fig. 1) in which no other plants are apparent. Close examination, however, will show that there are other plants associated with these grasses (fig. 1).

No attempt is here made to give a complete list of the plants which may occur in this association in addition to grama grass and buffalo grass, but a few of the more important species are given in the order of their importance in the lists below.

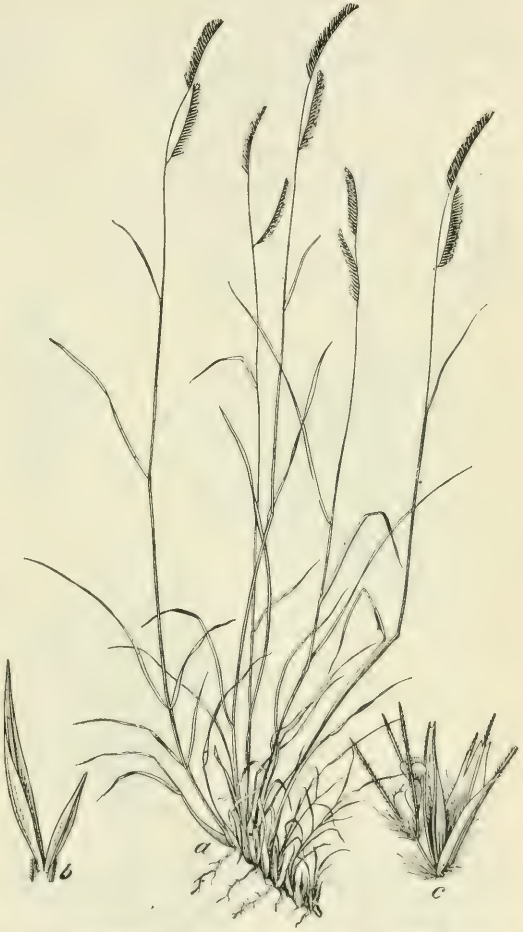

Fig. 2.—Grama grass (*Bouteloua oligostachya*). Typical plant, *a;* empty glumes, *b;* perfect and imperfect flowers, *c.*

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[a] Under this heading it seems best to give botanical names with citations of the author for convenience in referring to any standard manual for a botanical description of the plants. Author citations are thus avoided in other portions of the text except in connection with names which do not occur in the lists under this and similar headings. The following works will be found to be most useful in identifying the plants of this region: Britton, Manual of the Flora of the Northern States and Canada, 1901; Rydberg, Flora of Colorado, 1906; Robinson and Fernald, Gray's New Manual of Botany, 1908; Coulter and Nelson, New Manual of Botany of the Central Rocky Mountains, 1909.

Specimens of the species mentioned in this paper will be found on deposit in the National Herbarium, with the writer's identifications and reference to this bulletin.

The annual growth which occasionally becomes quite noticeable during June is composed largely of:

Festuca octoflora Walt.
Plantago purshii R. & S.
Draba micrantha Nutt.
Dysodia papposa (Vent.) Hitchc.
Salsola pestifer A. Nels.
Munroa squarrosa (Nutt.) Torr.
Leptilon canadense (L.) Brit.
Chenopodium leptophyllum (Moq.) Nutt.

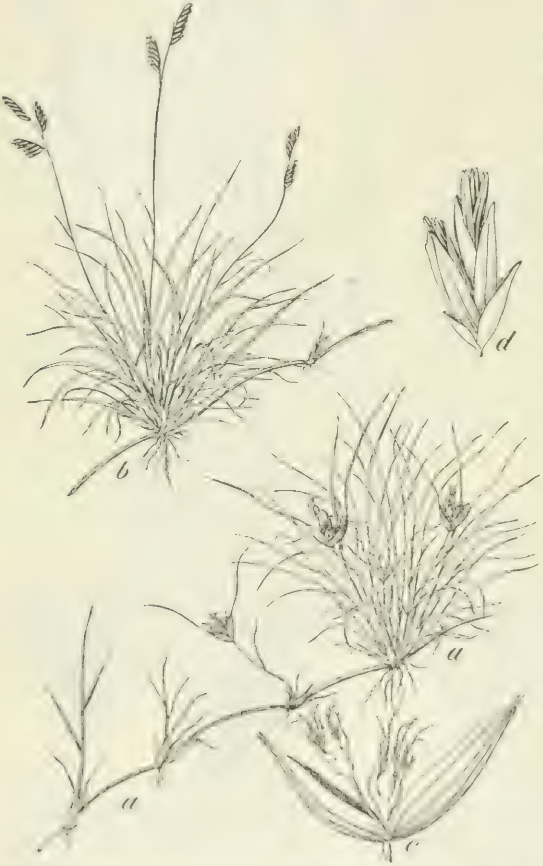

FIG. 3.—Buffalo grass (*Buchloë dactyloides*). Pistillate plant, *a*; staminate plant, *b*; pistillate spike, *c*; staminate spikelets, *d*.

The Festuca is the most important of these annuals. It is one of the most noticeable plants during wet periods in early spring. Often the landscape appears bright green largely because of the luxuriant growth of this small annual grass. It requires a very short season and will ripen in about thirty days. At its ripening period the appearance of the landscape is brown and dead. *Plantago purshii* is probably as uniformly distributed but not usually so abundant as the Festuca.

There is great variation from year to year in the amount of growth of these native annuals. They are especially abundant and noticeable during wet years. All are diminutive, the smaller plants of each species being hardly more than an inch in height, while the larger plants seldom reach a height of more than 6 inches. They are all short-season plants and are able to ripen a few seeds even under most unfavorable conditions.

The following longer lived plants are commonly found in this short-grass cover:

Schedonnardus paniculatus (Nutt.) Trelease.
Opuntia polyacantha Haw.
Opuntia fragilis Haw.
Echinocereus viridiflorus Engelm.
Mamillaria vivipara (Nutt.) Haw.
Malvastrum coccineum (Pursh) Gray.
Grindelia squarrosa (Pursh) Dunal.
Astragalus crassicarpus Nutt.
Sitanion hystrix (Nutt.) Smith.
Ptiloria pauciflora Raf.
Gaura coccinea Pursh.
Erigeron canus Gray.
Aragallus lambertii (Pursh) Greene.
Astragalus mollissimus Torr.
Erysimum asperum DC.

Of the longer lived plants which commonly occur in this short-grass cover one of the most noticeable is the cactus (*Opuntia polyacantha*), which forms extensive societies[a] at many places in the Great Plains. In eastern Colorado cactus occurs commonly, but is seldom of importance. Evidence shows that it was once far more abundant than at present, and many of the plants now found are dying as a result of fire and the attacks of parasites.

Schedonnardus and Malvastrum are found almost everywhere, but they never become dominant on the native sod. Grindelia in some places develops so abundantly that it becomes the most noticeable feature, dominating an extensive plant society.

Most of the plants listed have a root distribution approximately the same as that of the short grasses themselves. An exception is noted in the case of the species of Astragalus, which are deeper rooted, but, on the other hand, require only a very brief growing season.

Plants which often occur here but which are more characteristic of other associations within this formation are as follows:

Artemisia frigida Willd.
Gutierrezia sarothrae (Pursh) B. & R.
Aristida longiseta Steud.
Psoralea tenuiflora Pursh.
Agropyron smithii Rydb. (A. occidentale Scribn.).
Sideranthus spinulosus (Pursh) Sweet.
Chrysopsis villosa Nutt.
Eriogonum effusum Nutt.
Liatris punctata Hook.

All, or nearly all, of the species in the above list are better developed in the wire-grass association (p. 48), and their occurrence amid short grass, especially if they are abundant, indicates conditions approaching those found where the wire-grass association occurs. Several of these species reach their highest development in the Gutierrezia-Artemisia association (p. 60). The significance of the presence of these species is discussed in connection with these other two associations.

PHYSICAL CONDITIONS INDICATED.[b]

SOURCE OF DATA.

In order to give a clear account of the conditions under which the short grasses succeed, it is necessary to present some of the physical data obtained at Akron, Colo.,[a] during the growing season, from June 2 to September 27, 1909.

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[a] See footnote *c*, p. 20.

[b] The physical conditions of land originally occupied by vegetation of this type when under cultivation are discussed on p. 70.

In presenting these data only such records as are indispensable to the explanation of the conditions indicated by the different associations are included. Temperature, light, evaporation, etc., are practically uniform throughout eastern Colorado. The seasonal distribution of rainfall or the monthly rainfall is of far greater importance than annual rainfall, and is given here in order to help explain the conditions found in the different associations. Rainfall is the same for the different plant associations, and although this factor is discussed under only this one association the discussion applies equally to the others.

RAINFALL.

The following is the daily rainfall record in inches for the entire growing season of 1909 as recorded by the Physical Laboratory of the Bureau of Plant Industry at the Akron Experiment Farm.[b] This record gives a very good idea of the daily distribution of rainfall and is indispensable in interpreting the soil-moisture curves (figs. 5, 6, 7, 8, 9, and 10). A comparison of the diagrams in figure 4, as well as a comparison of the actual data on which these are based as given in Tables I and II, show very clearly that the season during which the soil-moisture determinations were made was unusually wet.

TABLE I.—*Days of rainfall and the amount of daily rain at Akron, Colo., April 1 to September 30, 1909.*

Day of the month.	Rainfall in inches.						Day of the month.	Rainfall in inches.					
	Apr.	May.	June.	July.	Aug.	Sept.		Apr.	May.	June.	July.	Aug.	Sept.
1			0.06			0.13	19		0.42	0.02			
2			.01			1.12	20	0.14	.31	.08			
4	0.14			0.02		.23	21				0.01		
5	.06		.01			.04	22		.06				
6			1.02	.01			23		.08				
7	.02	Tr.	.07	2.39	0.48	Tr.	24		.17	.07	.08	0.06	
8			.04	.32	.96		25		.08				
9			1.06	.09			27				.80		
10			.30				28		.12				
11	.04		.26				29				.89		
12		0.04				.36	30		.34				
13			.32			.28	31		.19			.89	
14					.74								
17		.06					Total.	.40	1.87	3.32	4.61	3.77	2.16
18					.64								

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[a] The writer's headquarters during the season of 1909, when the data here presented were largely obtained, were at the experiment farm of the Office of Dry-Land Agriculture, 5 miles east of Akron, Colo. The farm is located in an area covered by short-grass vegetation.

[b] Free access to the records in the office of the physicist of the Bureau of Plant Industry was accorded the writer. To Dr. L. J. Briggs the writer is indebted for the records of rainfall and evaporation at the Akron Experiment Farm, for moisture equivalent and hygroscopic moisture determinations of many soil samples, and for many determinations of moisture content on the cultivated plats. Although not here included, these records greatly aided in the general discussion of the conditions favorable or unfavorable for crop production on the short-grass land.

TABLE II.—*Average, maximum, and minimum monthly rainfall recorded at twelve stations in eastern Colorado previous to the year 1909.*

Month.	Average.	Maximum.	Minimum.	Month.	Average.	Maximum.	Minimum.
January	0.32	2.35	0	July	2.77	6.72	Trace.
February	.52	1.98	0	August	2.23	6.64	Trace.
March	1.08	4.47	Trace.	September	1.05	3.73	0
April	2.48	11.11	Trace.	October	1.00	3.20	0
May	2.46	9.77	Trace.	November	.46	4.40	0
June	2.61	6.30	.72	December	.42	2.00	0

The average monthly rainfall, as shown in Table II, is based on all of the monthly records up to and including 1908 for the following stations in eastern Colorado: Akron, Fox, Wallet, Burlington, Holyoke, Wray, Cheyenne Wells, Julesburg, Yuma, Cope, Siebert, and Leroy. The average length of record for the twelve stations is 13.4 years, and these data should give a very good general idea of the distribution and amount of monthly rainfall for this portion of the Great Plains. The least and the greatest monthly rainfall are also of interest to show the extremes.

The annual rainfall alone gives almost no idea of the conditions favorable or unfavorable for crop production, for crop failures often occur during the years with the greatest annual rainfall. The average annual rainfall for the twelve stations is 17.40 inches. The greatest annual rainfall for this region was recorded at Cope in 1898 and was 28.48 inches, while the lowest annual rainfall, 5.70 inches, was in 1893, at Fox, a few miles distant from Cope. There is no evidence, either from the vegetation or from the oldest of the Weather Bureau records, that the rainfall is permanently increasing or decreasing in amount.[a]

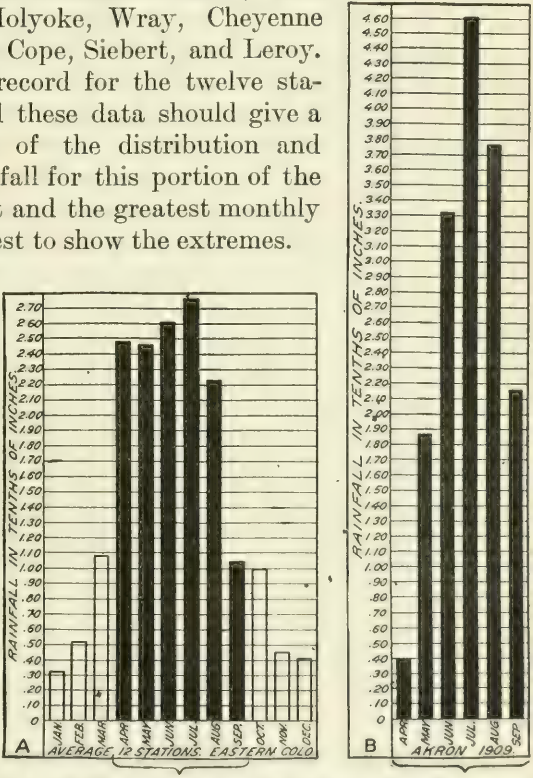

FIG. 4.—Diagrams showing: *A*, The average monthly precipitation based upon all records from twelve stations in eastern Colorado; *B*, the rainfall at Akron, Colo., season of 1909, for the months April to September, inclusive.

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[a] U. S. Weather Bureau, Precipitation in Western Kansas, Abstract of Data No. 2, 1907.

SOIL-MOISTURE CONTENT.

Soil-moisture determinations were taken on the Akron Experiment Farm twice a day from June 10 to September 10, 1909.[a] This sampling was done with a soil tube. In the morning samples were taken to a depth of 6 feet, the first 3 feet being in 6-inch samples while the second 3 feet were taken in samples of 1 foot each. In the evening samples were taken for each 6 inches to a depth of 3 feet only. Each sample for a given depth consisted of three cores. Several series of samples were taken before June 10 and one series of samples on September 27, thus extending the records from June 2 to September 27. In collecting this series of samples care was taken to select spots where comparatively pure short-grass cover occurred. Samples were taken as near together as possible, but with precautions to insure against the effect of water penetration from the holes where previous borings were made. The samples were thoroughly dried in an oven at 100° C. and the moisture content expressed in percentages of the dry weight of the soil.

The seasonal variations in available soil moisture, as calculated from the results of the daily sampling just described, are shown in the curves in figures 5, 6, 7, 8, 9, and 10. Each curve is made up of 184 points, except that curves for the soil below 36 inches contain only 95 points. The fluctuations observed in these curves are due largely to variations in the texture of the soil. These variations occur even at the short distances apart at which the corresponding samples were taken on successive dates. This is especially true with respect to the curves representing the water content in the deeper layers of the soil. In many places where the determination showed a low moisture content the soil sample was sandy; where high the soil contained more clay. If it had been possible to check each individual determination by a moisture equivalent or nonavailable moisture determination[b] the curves would show much less variation. However, the general trend of the curve is not vitiated by these fluctuations, since it is clear that they do not represent actual gain and loss in water but are the result of extremely local variations in soil texture.

The curves are based upon determinations of actual water content corrected to represent the amount of water available to the roots of

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[a] Prof. L. F. Childers, now of the Idaho Experiment Station, assisted the writer in this work as special agent of the Bureau of Plant Industry at Akron during the summer of 1909.

[b] See footnote, p. 18.

Kubanka wheat, as estimated from the moisture equivalent of soil from each depth.[a] In order to read them in terms of the actually observed water content it is necessary to add to the percentage represented at each point on the curves for the respective depths the percentages recorded in Table III.

TABLE III.—*Water nonavailable for Kubanka wheat in percentages of dry weight of soil, estimated from the moisture equivalent of a composite sample of all soil taken at each depth.*[a]

Depth in inches.	Per cent.	Depth in inches.	Per cent.	Depth in inches.	Per cent.
0– 6	9.6	18–24	10.5	36–48	7.1
6–12	14.5	24–30	9.2	48–60	7.0
12–18	12.8	30–36	7.9	60–72	6.3

The most interesting thing brought out by these curves is the fact that during the period of observation the rainfall did not at any time alter the water content of the soil below the first 18 inches. In fact, the curve representing the depth 12 to 18 inches was not influenced by a rainfall of as much as 2.40 inches on July 7 (fig. 5), nor by any of the rains which occurred later in the season (figs. 5 and 6).

A rainy period during the last of May and early June, before regular soil sampling was begun, influenced considerably the soil below 18 inches, as is shown by the subsequent general decline of the curves for 18 to 24 and 24 to 30 inches (fig. 7, *A*; fig. 8, *A*), from June 10 to about July 22, after which they remain approximately constant. The curves (fig. 7, *B*; fig. 8, *B*) show that the moisture content of this soil below 3 feet was not increased at any time during the season as a result of precipitation occurring after the sampling was begun and that on this hard land, even during the period when there was much more than the normal rainfall, the soil moisture available for Kubanka wheat was limited to the surface 3 feet of the soil.

Table IV summarizes the average available and nonavailable water between certain dates for each depth of the soil, and shows clearly the periods when water was available or not available. The average for each depth for the whole period is also given.

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[a] See Table XII, p. 78, and footnote. The particular lot of seed used in the pot-culture experiments by which the nonavailable moisture was determined for Kubanka wheat was that distributed by the Department of Agriculture, under Seed and Plant Introduction No. 5639.

TABLE IV.—*Periods when water was available and amount at each depth, in percentage of dry weight of soil, also general average at each depth for the whole season, June 7 to September 10, 1909.*

Depth of soil sampled (inches).	Period.	Average percentage of available water.	
		For period.	For whole season.
0-6	June 7 to June 24 a. m.	9.8	4.81
	June 24 p. m. to July 6	− 1.56	
	July 7 to July 19 a. m.	7.82	
	July 19 p. m. to July 26	− 1.71	
	July 27 to August 4 a. m.	4.67	
	August 4 p. m. to August 7	− 2.51	
	August 8 to August 27 a. m.	4.23	
	August 27 p. m. to August 31	− 2.32	
	September 1 to September 10	12.81	
	September 27	1.0	
6-12	June 7 to July 22 a. m.	5.67	2.72
	July 22 p. m. to September 3	− .40	
	September 4 to September 10	4.08	
	September 27	2.8	
12-18	June 7 to July 18 a. m.	4.84	1.25
	July 18 p. m. to September 10	− 1.54	
	September 27	− 1.7	
18-24	June 7 to July 19	3.23	.56
	July 20 to September 10	− 1.43	
	September 27	− 2.0	
24-30	June 7 to July 19	1.72	.23
	July 20 to September 10	− .81	
	September 27	− 2.1	
30-36	September 27	− 1.2	.04
36-48	do	− 1.2	− .61
48-60	do	− .3	− .09
60-72	do	.3	.02

As previously shown (fig. 4, p. 29), the season of 1909 was abnormally wet. Notwithstanding this fact, there were three periods when practically no water was available in any depth of the soil reached by the borings. These periods were from the evening of July 23 to the evening of July 26, inclusive; from the evening of August 4 to the evening of August 7, inclusive; and from the morning of August 28 to the evening of August 31, inclusive.

Below 6 inches there was no available water from July 22 to September 3, and below 12 inches there was none available later than July 19. Water was available in the soil at the depth of 30 to 36 inches during only a few days in June, and there is no evidence to show that water was again available in this layer after June 11. The soil below a depth of 36 inches was not influenced by the rainfall and its water content was practically constant through the season.

It is evident that except as an immediate result of the rainfall of a single day no water was available at any depth after July 22, and that even at such times the water available was found only in the surface foot of soil. For the period July 22 to September 1 the only available water at any time was in the surface 6 inches. The second 6-inch layer was only slightly affected by several rather heavy rains, and was brought above the nonavailable point by only two heavy rains, August 31 and September 1. It is also interesting to see that more than three days passed before the water added by these rains occasioned an increase in the water content of the second 6 inches.

The water content of the first 6 inches varied more than that of any other depth. During the season the water content of this first 6-inch layer fell below the available for several days at four different periods.

The water content of the soil from 6 to 12 inches remained below the available for a long period, July 22 to September 3, and also for the three days July 5 to 7. The water content of the soil from 12 to 18 inches did not fall below the point of availability until July 18, but after that date did not again rise to this point although many heavy rains were recorded. The same is true of the soil at depths of 18 to 24 inches and 24 to 30 inches.

A comparison of the rainfall at Akron during the season when these soil-moisture records were made with that of the average season for twelve stations in eastern Colorado (fig. 4) shows clearly that the seasonal rainfall was not only greater than the normal, but also that the period of greatest monthly rainfall began one month later and continued one month later than the normal. This being true it is probable that in a normal year the period of drought would occur much earlier in the season and that conditions would be much less favorable for the growth of plants.[a]

The point at which the water content of the soil becomes nonavailable for Kubanka wheat is comparatively low. From many observations in the field during several seasons and from experiments in the laboratory it is believed to be almost as low as that representing the nonavailable for many of the native plants of the grama-buffalo-grass association. This probability is supported by a consideration of the moisture content of the soil below 6 inches (fig. 6), which is protected from direct evaporation by the soil above. Nothing in the curves indicates that the native plants still extracted water from the deeper layers of the soil when their water content was below the available minimum for Kubanka wheat.

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[a] Daily soil-moisture determinations on this type of land to a depth of 10 inches, at Yuma, Colo., during July, 1907, showed available water in the soil during only seven days in the month, and occasional determinations during August, 1907, showed the soil to be much drier even than during July.

RUN-OFF.[a]

A great quantity of rainfall runs off directly and never enters the soil. The extent of the run-off, indicated by the many large, dry, gravelly stream beds which are found in short-grass regions, has been demonstrated by actual observation during heavy rains and by the measurements here recorded. From the results of the moisture determinations—the weight of the soil, the percentage of water it contains, and the amount of precipitation being known in each case—the quantity of water which entered the soil and the quantity of run-off was easily computed. At the place where the soil samples were taken and the run-off measured the land was comparatively level. It was possible, however, for water to drain over this area from the land adjacent on the north, and consequently the run-off recorded from this particular area was lower than the average for the region.

The results of all records of run-off at the base station at Akron, Colo., from June 11 to September 10 are given in summary form in Table V.

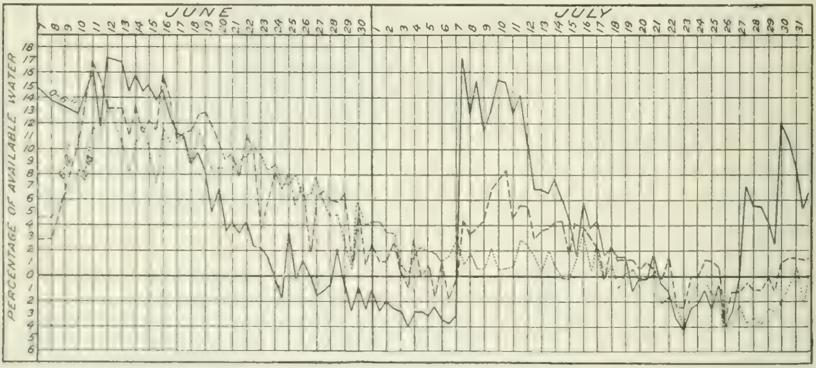

FIG. 5.—Diagram showing the daily available soil moisture, from morning and evening determinations for each 6-inch layer, 0–18 inches, in pure short-grass land, at Akron, Colo., Dry-Land Agriculture Experiment Farm, June and July, 1909.

The figures represent the average of the total quantity of water which entered the soil and which ran off, expressed in percentages of the total rainfall; they are not the results of averaging the percentages of run-off and penetration for each individual rain.

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[a] Variation in the water content of the surface soil, in the rate and amount of precipitation, in the physical condition of the soil surface, and in the slope all affect the amount of run-off. The run-off from the same area will therefore vary greatly at different times. The data given in Tables VI to XI, inclusive, were obtained at points where the slope of the land and the rate and amount of precipitation were the same, the chief factors which produced the variation having been differences in the water content of the soil and the physical condition of its surface. Comparisons of the data given in any one of these tables with those in any other must be checked by reference to the continuous record made at the base station. Direct comparisons of one table with another will lead to entirely erroneous conclusions.

TABLE V.—*Percentages of the total amount of run-off and of penetration on short-grass land at the base station, Akron, Colo., June 11 to September 10, 1909.*

Rainfall.	Number of rains.	Penetration.	Run-off.
		Per cent.	*Per cent.*
Rains of 0.10 inch or more	12	85	15
Rains of 1 inch or more	2	74	26
Rains of 0.50 to 1 inch	5	85	15
Rain of 0.10 to 0.50 inch	5	125	−25

With a rainfall of less than half an inch the soil invariably received more than 100 per cent of the precipitation. This indicates that there was some drainage to this land from higher levels and that the above data on run-off represent less than would actually occur on a larger and more representative area. In order to check these results, which were obtained at a single base station, measurements were made to determine the amount of water that penetrated the soil as a result of the rain of 0.89 inch on the night of August 31, 1909, at the base station and at five other points chosen to show the normal run-off for short-grass land during this rain. The results are given in Table VI.

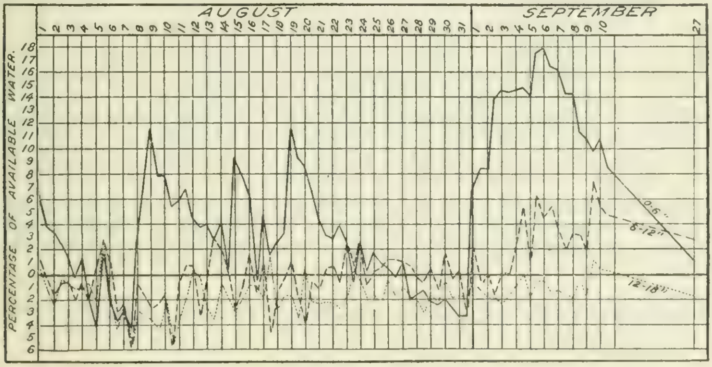

FIG. 6.—Diagram showing the daily available soil moisture, from morning and evening determinations for each 6-inch layer, 0–18 inches, in pure short-grass land, at Akron, Colo., Dry-Land Agriculture Experiment Farm, August and September, 1909.

TABLE VI.—*Run-off and water penetration on short-grass land at Akron, Colo., as a result of 0.89-inch rain August 31, 1909.*

Locality.	Penetration.	Run-off.
	Per cent.	*Per cent.*
Short-grass land at base station	90	10
Average at 5 other points chosen to show normal run-off on pure short-grass land	57	43

The data throughout the season at the base station show that 15 per cent of the rainfall did not enter the soil. Comparisons with the measurements at five other points show that the run-off at the base station was much below the average for land covered with short grass. The average run-off during this rain for the base station and the five other points was 37 per cent, while the run-off at the base station alone was only 10 per cent. If the seasonal average at the base station was proportionately low, the run-off from the six points must have averaged about one-half of the total rainfall for the same period.

RATE OF WATER LOSS.

The rate of water loss after penetration from short-grass land, estimated from determinations of the water content of the soil and from rainfall records, with correction made for run-off during each individual rain, is given in Table VII.

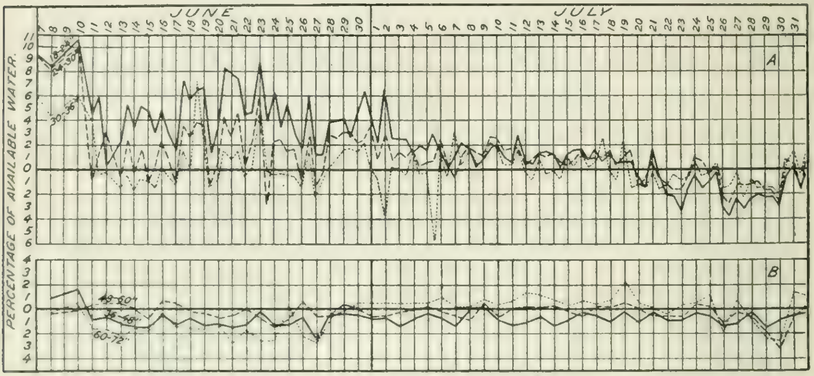

FIG. 7.—Diagrams showing the daily available soil moisture in pure short-grass land, at Akron, Colo., Dry-Land Agriculture Experiment Farm, June and July, 1909: *A*, From morning and evening determinations for each 6-inch layer, 18–36 inches; *B*, from morning determinations for each 12-inch layer, 36–72 inches.

TABLE VII.—*Average daily loss of water per square foot of surface from short-grass land and from free water surface for different periods during the season of growth.*

Date.	Average daily loss, in pounds per square foot of—	
	Short-grass cover.	Water surface.[a]
June 11 to July 7	1.07	1.40
July 10 to July 25	.94	1.56
July 27 to September 10	.42	1.45
June 11 to September 10	.67	1.43

[a] The evaporation data are taken from measurements made under the direction of Dr. L. J. Briggs, of the Physical Laboratory, Bureau of Plant Industry, at the Akron Experiment Farm.

Table VII shows a marked decrease after July 27 in rate of loss of water from land covered with short grass. This is to be explained largely by the fact that the short grasses were ripe at about that time and transpiration from the plant cover had therefore greatly diminished. These data are especially interesting in showing that transpiration by the short grasses (when in good growing condition) and evaporation from the soil itself exhaust an amount of water equivalent to the entire average rainfall of the period from April to August, inclusive, in about sixty-five days; or exhaust the rainfall of the grain-growing season, April to July, in about fifty-three days.

A comparison of the rate of loss for the two periods, June 11 to July 7, and July 27 to September 10, will throw light upon the question of how much of the water taken out of the soil was due to the transpiration of the short-grass vegetation. During the first period this vegetation was luxuriant, and as a partial consequence the average daily water loss was high, 1.07 pounds per square foot.

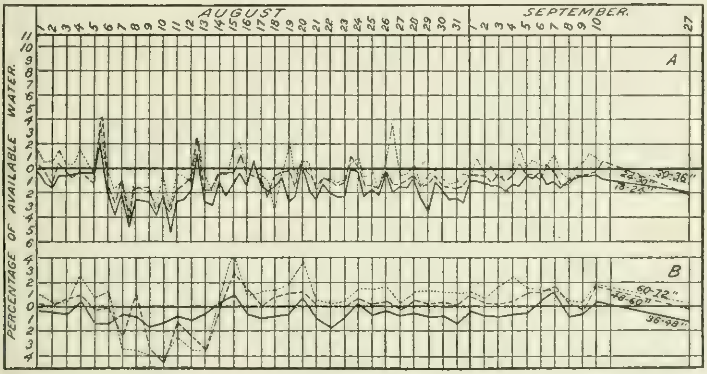

FIG. 8.—Diagrams showing the daily available soil moisture in pure short-grass land, at Akron, Colo., Dry-Land Agriculture Experiment Farm, August and September, 1909: *A*, From morning and evening determinations for each 6-inch layer, 18–36 inches; *B*, from morning determinations for each 12-inch layer, 36–72 inches.

During the last part of the season the short grasses were nearly dormant and the rate of loss was low, 0.42 pound per square foot of surface. This would indicate that considerably more than one-half of the water loss from June 11 to July 25 was due to the transpiration of the short-grass vegetation, while considerably less than half was due to direct evaporation from the soil.

The evaporation data in the right-hand column show that the difference observed in the rate of loss of water from the soil during the two periods was not due to differences in the evaporating power of the air. Reference to the curve of water content of the soil for the first 6 inches (figs. 5 and 6) also shows that the differences in rate of loss of water can not be explained on the basis of differences in the rate of evaporation from the soil due to change in its moisture content. It seems safe to assume from these data that the transpiration from the short-grass cover during its period of active growth is responsible for considerably more than 50 per cent of the water loss.

ADAPTATION OF SHORT-GRASS VEGETATION TO PHYSICAL CONDITIONS.

The above data show that the conditions on pure short-grass land are such as to limit the depth to which water penetrates, even after heavy rains, to a few inches of the surface soil. The soil is only rarely wet down to a foot or two. Almost the entire root system of the short grasses is limited to the surface 18 inches of soil (fig. 11). The water which actually enters the soil is rapidly lost by the transpiration of the short grasses and by direct evaporation. Deep-rooted plants are not found here for the reason that at greater depths the soil contains no water available for their use.

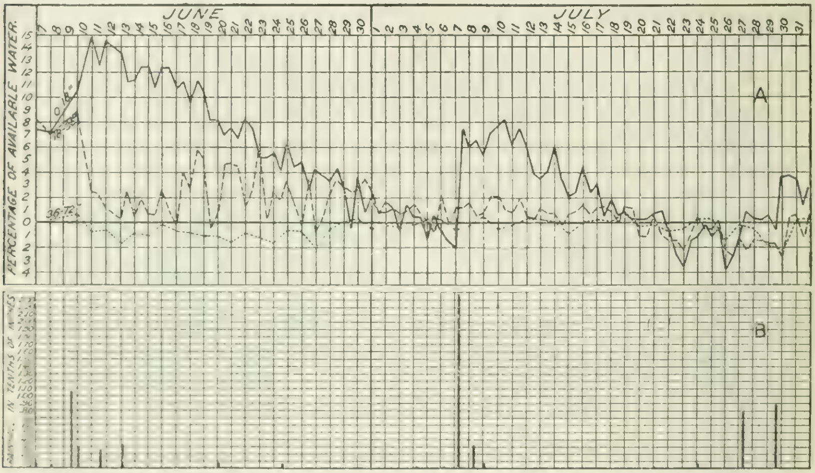

FIG. 9.—Diagrams showing, at Akron, Colo., Dry-Land Agriculture Experiment Farm: *A*, The daily available soil moisture, from morning and evening determinations for layers of soil at depths of 0-18, 18-36, and 36-72 inches, respectively, in pure short-grass land, June and July, 1909; *B*, the daily rainfall from June 7 to July 31, 1909.

Short-grass vegetation is also an indicator of a rather short season favorable for growth. In this plant association the growing season is determined, not by the length of period of suitable temperature, but by the length of the period when the soil moisture is sufficient to maintain growth. Grama grass requires approximately sixty days for maturing and often fails to ripen its seed, largely because of insufficient water supply. Buffalo grass usually flowers and fruits early in the season, but when the early season is dry its fruiting may occur at any time during the summer when the water supply is sufficient. It usually blossoms in May, but during the season of 1908 in portions of the Great Plains did not flower until the latter part of August. The principal adaptation of these grasses to arid conditions seems to lie in their ability to dry out, as do many lichens and mosses, and to revive quickly when water is again supplied. During periods of excessive precipitation both species of grasses grow and fruit luxuriantly. In all probability they would thrive much better under conditions of increased water supply were it not for the fact that under these conditions competition with other species becomes too severe and the short grasses are shut out. These short grasses have a very extensive surface-root system (fig. 11) and are especially adapted to conditions found in the Great Plains region on this type of land. After a slight rain, when only the first few inches of the soil becomes wet, these plants are able to absorb water and grow. An enforced rest seems to do them no injury, and with the next shower they are able to continue their growth. Practically the same thing is true of the other species listed (p. 27) as occurring in this short-grass association.

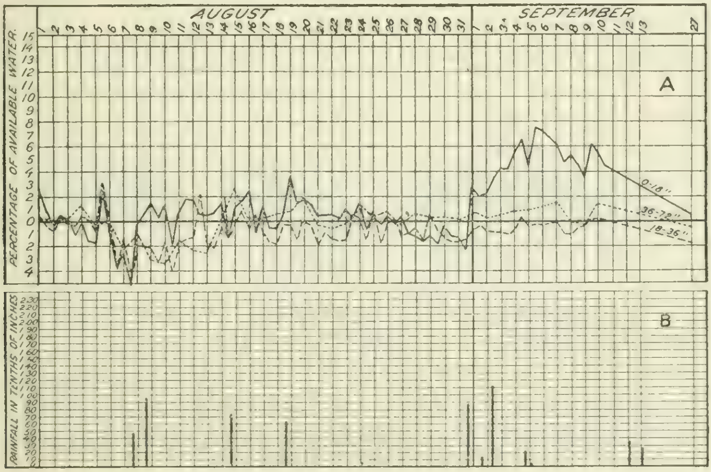

FIG. 10.—Diagrams showing, at Akron, Colo., Dry-Land Agriculture Experiment Farm; *A*, The daily available soil moisture, from morning and evening determinations for layers of soil at depths of 0–18, 18–36, and 36–72 inches, respectively, in pure short-grass land, August and September, 1909; *B*, the daily rainfall, August 1 to September 27, 1909.

During years of more favorable water supply an increased growth of annuals takes place. These, however, are usually found in the grass mats (fig. 1, p. 17), probably because of the fact that here the moisture conditions are more favorable for germination. The shade afforded by the grasses does not seem to be the deciding factor, since the seeds of many of the Great Plains species germinate better in light than in shade.

Conditions are not very favorable for the development of annuals on the short-grass land. A glance at the curve of available water (figs. 5 and 6) will show that seldom even during a wet year is the water content of the surface 6 inches of the soil high enough for growth during a period of more than a few days at a time. A rapid root development, as well as ability to resist desiccation, are essential to the successful growth of annuals in this environment. They also show remarkable ability to adjust the amount of growth, and hence the time of flowering and fruiting, to the supply of moisture available.

The texture of the soil indicated by short-grass vegetation in this region is a loam, the type of land known locally as "hard land," similar to that called "tight land" in Texas.

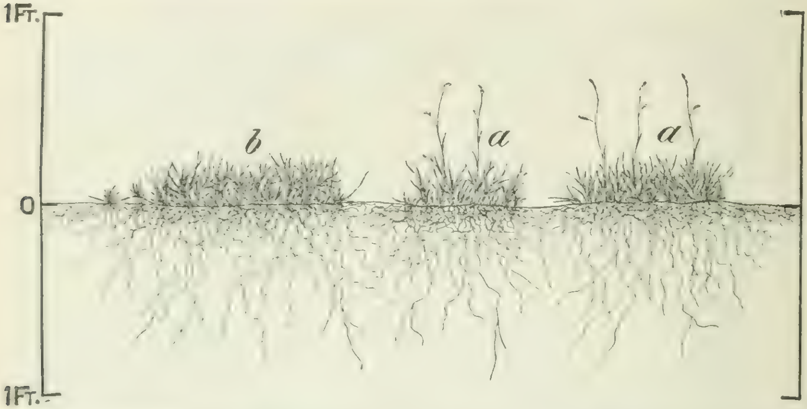

FIG. 11.—Sketch showing root systems limited to the surface soil in the grama-buffalo-grass association. Grama grass, *a;* buffalo grass, *b.*

THE EFFECT OF DISTURBING FACTORS.

BREAKING.

The effect of breaking or plowing under the short-grass cover on land that is subsequently abandoned is most marked. It results in starting a succession which requires from twenty to fifty years to complete itself by reestablishing on the area the same vegetation as that turned under. The effect of breaking varies somewhat, and the succession which ensues is determined more largely by the physical conditions than by the composition of the adjacent vegetation. The conditions for seed dispersal by wind are so favorable on the Great Plains that new land can be seeded by plants growing many miles away. The plants which enter this new area are consequently not necessarily those found immediately adjacent to the area. It often happens that a vegetation of Gutierrezia and Artemisia establishes itself upon plowed land which is in close proximity to an area occupied by the wire-grass association, and vice versa. Many examples of this kind show clearly that the physical conditions are more important in determining what the succession shall be than the relative number of seeds of the different species which are carried into the denuded land. If the vegetation has been derived from the Gutierrezia-Artemisia association (p. 60) and occurs on land exhibiting the environmental conditions that favor that association, breaking will result first in a ruderal or weed stage composed of annuals or short-lived plants. This will be followed by a mixed vegetation in which Gutierrezia (fig. 22, p. 66) or Artemisia (fig. 23, p. 67) predominate or are associated (Pl. II, fig. 1).[a] Short grasses will gradually enter, and the later stage of this succession will show sharply alternating areas of short grass and of Artemisia or Gutierrezia. The complete reestablishment of the short-grass cover will be very slow and will probably not be fully accomplished inside of thirty to fifty years.

If, however, the composition of the short-grass vegetation is more nearly related to that of the wire-grass association (p. 48), and the conditions are therefore more favorable to this association than to the Gutierrezia-Artemisia association, breaking will result in throwing it back into the wire-grass association and the succession will then be as follows: First, an initial ruderal or weed stage[b] not differing essentially from that mentioned above. This stage is only temporary. Either of the two grasses, *Schedonnardus paniculatus* and *Sitanion hystrix*, mark the end of the ruderal stage or the beginning of the permanent stage in this succession. Wire-grass (*Aristida longiseta*, fig. 13, p. 49) will then gradually become established over small alternating areas and the Schedonnardus will gradually die out. Schedonnardus is a short-lived grass, and although it often dominates the early stages of this succession it offers no resistance to the establishment of the taller wire-grass, which crowds it out by overshading it. The condition of the water supply, however, is not such as to support a dense growth of Aristida, and this cover is consequently of a sparse nature and offers an excellent opportunity for the entrance of the short grasses between the scattered bunches (Pl. II, fig. 2). As these short grasses gradually become established they use up more and more of the water supply which would otherwise go to the deeper rooted wire-grass, which, as a result, gradually dies out, leaving a pure short-grass cover. The succession is very slow, requiring from twenty to forty years for completion.

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[a] In the northern or northwestern portion of the Great Plains *Artemisia frigida* will probably predominate, while in the southwestern portion *Gutierrezia sarothrae* will predominate. In the central or west-central region, the portion especially considered in this paper, either or both species will become dominant in this stage.

[b] The ruderal stage varies considerably from place to place. It is usually represented by some of the following species:

Dysodia papposa (Vent.) Hitchc.
Festuca octoflora Walt.
Salsola pestifer A. Nels.
Solanum rostratum Dunal.
Malvastrum coccineum (Pursh) Gray.
Munroa squarrosa (Nutt.) Torr.
Plantago purshii R. & S.
Amaranthus retroflexus L.
Amaranthus graecizans L.
Amaranthus blitoides Wats.
Chenopodium leptophyllum (Moq.) Nutt.
Lappula occidentalis (Wats.) Greene.
Chenopodium album L.
Solanum triflorum Nutt.
Euphorbia glyptosperma Engelm.
Leptilon canadense (L.) Brit.

Of these, the tumble weeds, *Amaranthus graecizans* and *Salsola pestifer*, are often the most important species during the first year. Many of these weeds are grazed close to the ground by cattle, and doubtless close grazing greatly reduces the amount of ruderal growth. This aids in the establishment of the grasses by the removal of the taller weeds and also by reducing the rate of water loss from the soil.

It will be seen from the above discussion that the result of breaking and subsequently abandoning short-grass land is to cause the temporary establishment of a vegetation which is of a deeper rooted type and is normally characteristic of a lighter[a] or less fully disintegrated[b] soil. This is partly due to the fact that the soil has been loosened by the plowing, thus allowing water to enter more readily. Under natural conditions the soil surface in short-grass land is very hard and somewhat puddled. Breaking changes this condition and enables a greater quantity of water to enter the soil. This is especially true of land that has been plowed and subsequently not well worked down. Even in places where the soil had been left undisturbed for eight years after breaking a great difference in water content was noted in the second and third foot as compared with the same depths under unbroken sod. This condition is probably largely due to the fact that the removal of the short-grass cover by breaking decreases the loss of water that is due to absorption by the roots of these grasses. This allows the water to penetrate deeper into the soil, thus establishing a condition more favorable for deep-rooted plants.

GRAZING.

Ordinary grazing does not appreciably modify the short-grass cover. In fact, it seems that grazing somewhat favors the development of pure short-grass cover. Excessive grazing may result in one of two modifications. If the overgrazed portion of the association has recently been derived from the Gutierrezia-Artemisia association (p. 60), and presents soil conditions very similar to those normally found under that association, it will revert to that association.

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[a] See wire-grass association, p. 48.

[b] See Gutierrezia-Artemisia association, p. 60.

This is the condition in southern Colorado, northeastern New Mexico, and portions of Texas where the Gutierrezia has again become established on heavily grazed land. The ranchers maintain that the range was once covered with a pure short-grass vegetation, but that grazing, and particularly sheep grazing, has caused the introduction of the Gutierrezia. The vegetation has been disturbed to such an extent that it has reverted to the earlier stage, i. e., the Gutierrezia-Artemisia association, from which in time it will pass again into the short-grass stage if protected from excessive grazing.

If, however, the area of short grass has been derived from the wire-grass association (p. 48), and presents conditions which especially favor that association, excessive grazing will cause it to revert to the wire-grass type of vegetation.

The reversion is made possible by the great reduction in the amount of short grass and the resulting reduction in loss of water from the soil. A smaller percentage of the water is absorbed in the upper layers of the soil and consequently more of it can go to the support of the deeper rooted Gutierrezia or Aristida. Neither Gutierrezia nor Aristida is eaten by animals, and these plants are consequently greatly favored by excessive grazing and the removal of the short grasses with which they are in competition for the soil water.

FIRES.

The effect of fires must be regarded as having been always operative in the Great Plains region. Fires are started by lightning during almost every thunderstorm, and the advent of man has, if anything, tended to check rather than to increase their ravages. The effect of fires on short-grass vegetation in eastern Colorado results in modifying this vegetation very markedly. Grama grass seems to suffer but little, but in places that have been repeatedly burned the buffalo grass is completely killed out. Places of this kind are marked by a pure grama-grass vegetation. Burning also removes all the dead leaves as well as the living ones, and may consequently lead to the impression that the total quantity of plant growth has been much less than is actually the case.

PARASITIC FUNGI.

In places fungus diseases play a part in modifying the short-grass cover. The two common parasites of buffalo grass, *Cercospora seminalis* Ell. and Ev. and *Tilletia buchloëana* Kellerm. and Swingle, do injury chiefly by preventing seed production. They are of minor importance except in their relation to the reseeding of areas from which the plant covering has been removed. Two fungi parasitic on the grama grass, *Ustilago hieronymi* Schröt. and *Puccinia bartholomewii* Diet., may modify the plant cover to a considerable extent. This is especially true of the Ustilago, which in places reduces the grama to a very thin and scattered cover. Cursory observation might lead to the error of attributing this condition to unfavorable soil conditions. The disease can be recognized by the prominent smut blisters on the leaves, especially noticeable in early spring.

Variations from the Typical Grama–Buffalo-Grass Association and what these Variations Indicate.

Before taking up the more marked variations from the type it will be well to consider some slight modifications in the nature of the plant cover where the vegetation still remains essentially a true short-grass type.

AN OPEN-MAT COVER.

In many places on the Great Plains the plant cover is such as can be designated an "open mat," not more than 15 to 30 per cent of the surface being actually covered with plant growth. The bare places are always irregular in shape and are usually unoccupied, even during periods when annuals develop, for the greater number of the annuals are found within the mats of grama and buffalo grass (fig. 1, p. 17). This open type of short-grass vegetation must be considered as indicating a condition less favorable for plant growth and crop production than where the ground is fully covered. As a rule it is found much more commonly in regions where the rainfall is smaller or less evenly distributed, but it may occur in almost any part of the Great Plains, especially in places where the run-off is very great. The comparative percentages of run-off from ordinary short-grass cover and from open-mat cover as a result of a rainfall of 0.89 inch on the night of August 31, 1909, at Akron, Colo., are given in Table VIII.

Table VIII.—*Comparative water penetration and run-off from ordinary pure short-grass cover and from open-mat cover, as a result of 0.89-inch rain, August 31, 1909, at Akron, Colo.*

Description of cover.	Penetration.	Run-off.
	Per cent.	*Per cent.*
Ordinary pure short-grass cover	62	38
Scattered mats of short grass with a little Schedonnardus	28	72

In all probability a balance is established between the amount of soil water available and the amount of plant growth produced, the growth being, therefore, an indication of the average moisture condition at that particular place. This open-mat phase sometimes signifies an earlier stage in the development of the true short-grass association. It may be produced by fire (p. 43) or by fungous diseases (p. 43), and when due to these causes does not indicate unfavorable physical conditions for the production of a cultivated crop.

A CLOSE-MAT COVER.

As the other extreme from the open mat we may have a condition where the plant growth is so dense that at first glance the ground appears to be entirely covered. The vegetation affords little opportunity for the entrance of other plants without the displacement of those already established. The close cover as compared with the ordinary short-grass vegetation signifies a soil more uniformly supplied with water and one which, when broken for cultivation, will produce better crops than that occupied by a more open cover. Exceptions should be noted when dense growths of pure buffalo grass are found in depressions where water stands after a rain. Such occurrences are not to be regarded as indicating favorable conditions for crop growth.

These differences in the amount of plant growth unaccompanied by differences in the species represented are of considerable importance as indicators of possible crop production. The appearance of other species usually accompanies more profound differences in the habitat and on this account is of greater indicator value than mere variations in the amount of growth produced. Several modifications of the latter type will now be described.

ARTEMISIA AND GUTIERREZIA ON SHORT-GRASS LAND.

In many places various perennial plants, chief among which are *Artemisia frigida* (fig. 23, p. 67) and *Gutierrezia sarothrae* (fig. 22, p. 66), establish themselves amid the short-grass cover. These plants indicate a condition intermediate between the true grama–buffalo-grass association and the association which is dominated by the perennial species mentioned. As a rule their presence indicates a less thoroughly disintegrated soil, a soil in which water penetrates somewhat deeper than where the pure short grass is found, but not so well adapted for the production of cultivated crops. Care should be exercised, however, in estimating the value of land of this type, since overgrazing or previous breaking will often introduce this type of vegetation on land which would otherwise be occupied by pure short-grass cover. Where this type of vegetation occurs naturally without the intervention of one of the above-mentioned causes, the land is to be regarded as very nearly of the type that is characterized by the Gutierrezia-Artemisia association, which will be discussed later (p. 60).

ASTRAGALUS ON SHORT-GRASS LAND.

The native Leguminosæ, especially *Astragalus crassicarpus*, *A. mollissimus*, and *Aragallus lambertii*, are rather deep rooted, but have a very short season of growth. They are, therefore, not to be regarded as indicating better physical conditions than does the pure short-grass cover, and they do not denote conditions favorable for the production of crops like alfalfa, which requires a long season.

PSORALEA ON SHORT-GRASS LAND.[a]

The occurrence on short-grass land of *Psoralea tenuiflora* (fig. 12 and Pl. III, fig. 1), sometimes called "wild alfalfa," and of other deep-rooted plants which require a comparatively long season is to be regarded as an indication of a greater depth of moisture penetration in the soil. Psoralea is always a deep-rooted plant (fig. 14, p. 51), the roots extending to a depth of 4 to 6 feet. As in most of the native legumes of the region, the rootlets are well supplied with nodules for the absorption of nitrogen (fig. 12, *a*). Where this plant is distributed uniformly it indicates either a soil which is more readily penetrated by water than normal short-grass land, or else a place which receives the run-off from an extensive area and which, consequently, is penetrated by more water than that which falls upon it as rain. Accordingly, it indicates a condition more favorable for agricultural purposes than is represented by a pure

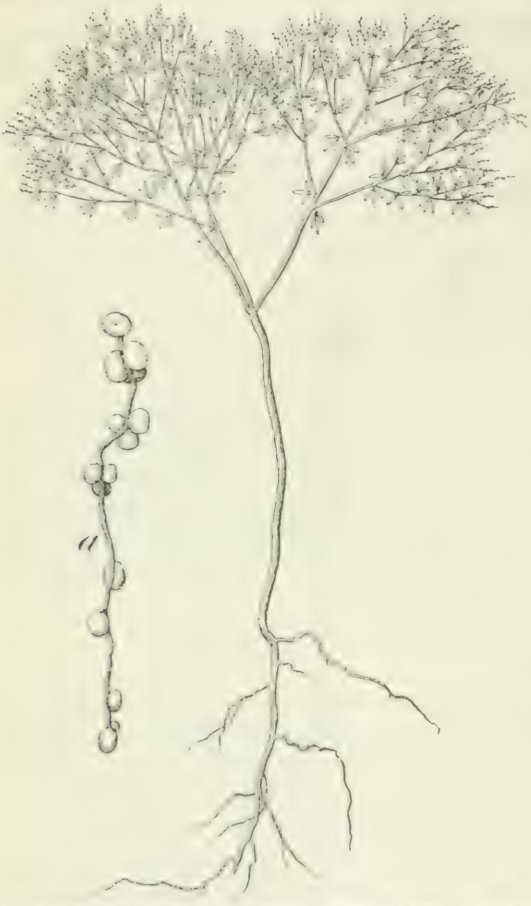

FIG. 12.—Sketch (drawn from photograph) showing a single plant of *Psoralea tenuiflora*. The root extends to a depth of 5 feet and has no further branches. The rootlet, *a*, showing nodules, which was taken at 3 feet below the soil surface, is about natural size.

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[a] *Psoralea tenuiflora* society.

short-grass cover. Where Psoralea plants occur only in small scattered communities, they indicate pockets of looser soil or depressions into which water drains from surrounding areas. Communities of Psoralea in many places mark animal burrows which have been abandoned for some time and which afford ready means for water to penetrate to deeper layers of the soil. The location of areas previously occupied by communities of Psoralea can be detected easily by the condition of the cultivated crop during dry periods. These areas are indicated by the "good spots," and if the land has not been under cultivation for a period sufficient to kill out the Psoralea it will be found still growing amid the crop in the greater number of these areas.

A careful series of comparative measurements of penetration and run-off were made following a rain of 0.89 inch at Akron, Colo., on the night of August 31, 1909, the results of which are shown in Table IX. Care was taken to make the comparative borings on slopes having as nearly as possible the same inclination.

TABLE IX.—*Comparative run-off and water penetration on pure short-grass land and at places where Psoralea is present.*

Description of plant cover.	Penetration.	Run-off.
	Per cent.	*Per cent.*
Pure short-grass land	59	41
Close short-grass cover and Psoralea	176	−76
Pure short-grass land	81	19
Close short-grass cover and Psoralea	140	−40
Pure short-grass land	62	38
Close short-grass cover, wire-grass, and Psoralea	137	−37
Pure short-grass land	90	10
Psoralea clump on short-grass land	274	−174
Pure short-grass land	90	10
Psoralea clump on short-grass land	140	−40
Pure short-grass land	90	10
Psoralea and wire-grass on short-grass land	214	−114
Pure short-grass land	90	10
One Psoralea plant on short-grass land	226	−126
Average for pure short-grass land	80	20
Average for other places	201	−101

Each comparison was made between spots where Psoralea was present as part of the vegetation and where Psoralea was absent, only a few feet away. These measurements show conclusively that where Psoralea occurs the conditions as to soil moisture are more favorable than where the short grass occurs alone.

WIRE-GRASS ON SHORT-GRASS LAND.[a]

The occurrence of scattered plants of wire-grass (fig. 13, p. 49) amid the short-grass cover (Pl. III, fig. 2), indicates somewhat the same conditions as where Psoralea is abundant. Usually, however, wire-grass is not found in the low places where water is likely to stand after heavy rains. It is mainly an indicator of a soil into which water penetrates more readily.[a] The conditions indicated by this vegetative cover are intermediate between those of a pure short-grass vegetation and the typical wire-grass association. Wire-grass is deep rooted and has practically no surface-feeding roots (fig. 14, p. 51). Consequently, it is dependent entirely upon such moisture as occurs at a depth greater than one foot in the soil. It is therefore to be regarded in this region as one of the most reliable plants for indicating favorable agricultural conditions.

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[a] *Aristida longiseta* society.

WHEAT-GRASS ON SHORT-GRASS LAND.

The wheat-grass association of the Great Plains, characterized by the predominance of western wheat-grass (*Agropyron smithii*), occurs most extensively west of the Missouri River in South Dakota, especially on the adobe soil derived from the Fort Pierre shale. In Colorado it also occupies rather extensive areas of the same kind of soil, although it is not by any means limited to this type. It seems to thrive under a great variety of conditions, penetrates farther into alkali land than do the short grasses, and is equally adapted to resist drought, chiefly by its ability to revive after desiccation. When a sod composed of wheat-grass and short grass is broken and allowed to remain without cultivation the growth of wheat-grass is greatly increased. The wheat-grass plants are not killed by this process and there is a much more abundant water supply available to them as a result of the destruction of the short grasses. In the present stage of these investigations its value as an indicator of the capabilities of crop production remains doubtful.

THE WIRE-GRASS ASSOCIATION.

General Appearance.

Intermediate in character between the short-grass and the bunch-grass types of vegetation, the wire-grass association occurs most commonly on soils of intermediate character which lie between the hard lands and the sand hills. It forms a rather extensive association in certain places in eastern Colorado, being particularly abundant in Washington and Yuma counties. It is found in practically all localities where the short-grass formation and the bunch-grass association meet, and outside of the immediate region under consideration is probably best developed in west-central Kansas and Nebraska.

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[a] After a rain of 0.89 inch at Akron, Colo., August 31, 1909, the following comparative penetration and run-off were observed: Pure short-grass land, penetration 36 per cent; run-off 64 per cent. Wire-grass amid short-grass cover, penetration 56 per cent; run-off 44 per cent. There was a decided slope where these determinations were made.

The wire-grass association is much more varied in general appearance than the grama–buffalo-grass association. The ground is covered by a short-grass mat which is usually not so dense as that of the typical grama–buffalo-grass association. Overtopping this mat are numerous taller plants of many different species, among the more important of which are wire-grass (fig. 13) and Psoralea (fig. 12, p. 46). The wire-grass appears as low tufts which, because of their light silvery color, can be distinguished at once from the so-called bunch-grass which is taller and reddish brown in color. The wire-grass association embraces a much greater number of species than does the grama – buffalo - grass association. Even those phases of the latter which most nearly approach the wire-grass association have nothing like its variety of taller plants. Two of the most important plants, the Psoralea and the bush morning-glory, are tumbleweeds, and leave no trace of their existence when the growth period is past. If the country is fenced the drift of these plants along the fences and roadways will indicate clearly the type of vegetation. The illustration (Pl. I, fig. 2) gives an idea of the general appearance of this association.

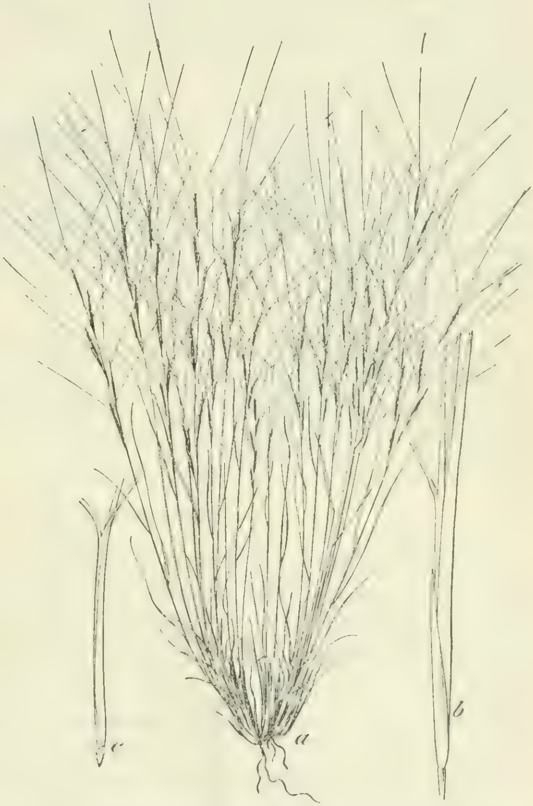

Fig. 13.—Wire-grass (*Aristida longiseta*). Plant, showing habit, *a;* spikelet, *b;* flowering glume, *c*.

Botanical Composition.

The wire-grass association, being intermediate between the bunch-grass and the grama–buffalo-grass associations, is made up of species which may be at home in either. The matlike cover is composed largely of the common grama grass (*Bouteloua oligostachya* (Nutt.) Torr., fig. 2, p. 25), although the black grama (*Bouteloua hirsuta* Lag. fig. 17, p. 59) often becomes an important factor. Buffalo grass, on the other hand, is rather rarely found, its place being taken by the black grama. Intermingled with the short-grass mat we find a great many other plants. In addition to the characteristic species, wire-grass (*Aristida longiseta* Steud., fig. 13) and *Psoralea tenuiflora* Pursh (fig. 12, p. 46), many other plants occur of which a few are here listed in order to give a better idea of the composition and general appearance of this association:

Ipomoea leptophylla Torr.
Malvastrum coccineum (Pursh) Gray.
Ratibida columnaris (Sims) D. Don.
Hymenopappus filifolius Hook.
Sideranthus spinulosus (Pursh) Sweet.
Echinocereus viridiflorus Engelm.
Liatris punctata Hook.
Thelesperma gracile (Torr.) Gray.
Erigonum effusum Nutt.
Chrysopsis villosa Nutt.
Lupinus pusillus Pursh.
Schedonnardus paniculatus (Nutt.) Trelease.
Stipa comata Trin. & Rupr.
Sporobolus cryptandrus (Torr.) Gray.
Festuca octoflora Walt.
Carex stenophylla Wahl.

The greater number of these plants are deep-rooted perennials and require a rather long season of growth. In addition to these plants, all the species recorded as occurring in the grama-buffalo-grass association (p. 25) and in the bunch-grass association (p. 54) may be found occasionally in this association.

PHYSICAL CONDITIONS INDICATED.[a]

The conditions in land occupied by the wire-grass association are such as to permit the growth of both shallow-rooted and deep-rooted plants (fig. 14). The shallow-rooted species are chiefly short grasses which obtain most of their water supply from the first foot of the soil. The texture of the soil is such, however, that water penetrates with comparative rapidity. Approximately all of the rainfall is absorbed, and since the soil is rather light in character, usually a sandy loam, this amount of water is sufficient to penetrate to a depth of several feet. As a result of these conditions this land supports also a deep-rooted type of vegetation which is characterized largely by wire-grass, Psoralea, bush morning-glory, and many other comparatively tall and deep-rooted plants. The wire-grass has practically no surface roots, the roots penetrating deep into the soil and being adapted only to conditions where the soil is moist to a considerable depth. The same is true of Psoralea, bush morning-glory, and the other deep-rooted plants.

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[a] The physical conditions of land originally occupied by vegetation of this type when under cultivation are discussed on p. 75.

The presence of short grass, however, indicates a condition unfavorable to the greatest development of the taller, deep-rooted plants. If the water supply were increased the latter would undoubtedly entirely replace the short grass and the vegetation would probably pass over into the bunch-grass association.

The amount of water available below the first foot of soil determines the number of deep-rooted plants which can develop. Since in the wire-grass association this amount is not sufficient to produce a dense growth of such plants, interspaces are left which are occupied by the shallow-rooted, short grasses. The presence of the short grasses further reduces the amount of moisture available to the deeper rooted plants but can not crowd them out entirely because of the fact that in this readily permeable soil the rain water passes below the surface layer before the short grasses can utilize all of it. A condition of unstable equilibrium therefore exists, being more favorable for the deep-rooted plants during wet years and more favorable for the short grasses during dry years.

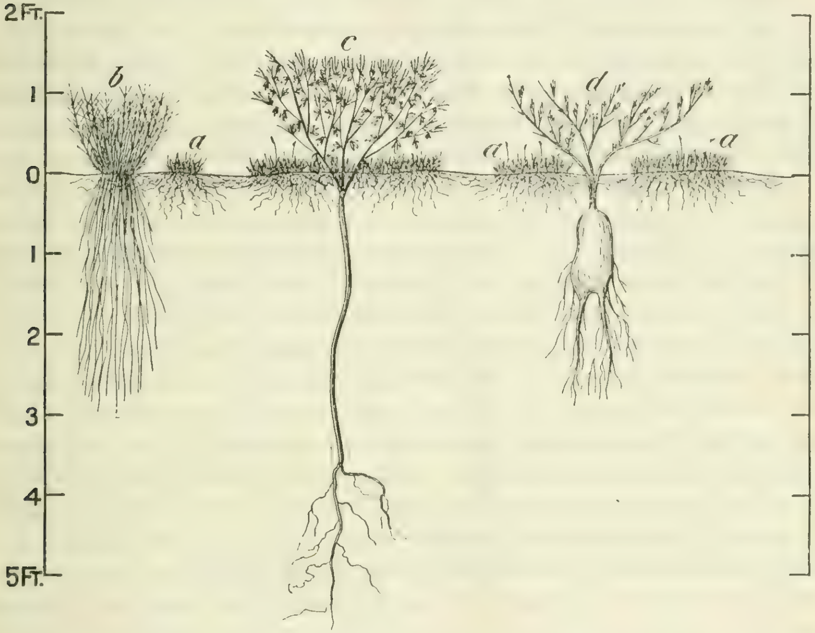

FIG. 14—Sketch showing root distribution in the wire-grass association. Shallow-rooted grama grass, *a*; alternating with deep-rooted wire-grass, *b*; Psoralea, *c*; bush morning-glory, *d*.

The conditions indicated by the wire-grass association are undoubtedly the most favorable for crop production of any found in eastern Colorado, since the soil is heavy enough not to blow badly and forms a stable substratum for all types of crops. At the same time it is pervious enough to enable a very high percentage of the rainfall to enter. The water loss from the soil surface is much less rapid than from the harder lands that are characterized by short-grass vegetation. This is due to the fact that the surface layers, being sandy, dry out very rapidly after a rain and thus soon form a protective dry mulch which checks evaporation. The greater part of the water lost by this soil is through transpiration by the plant cover.

EFFECT OF DISTURBING FACTORS.[a]

Breaking.—When wire-grass vegetation is plowed under and subsequently left without cultivation the result is the introduction of vegetation characteristic of a lighter type of land. The first vegetation is a weed stage which is soon followed by a stage of longer duration in which the grass *Sporobolus cryptandrus* is an important element. But this stage is by no means a pure grass stage, for many other plants also enter. Aristida next appears and at times the bunch-grass (*Andropogon scoparius*). The short grasses, chiefly gramas, are gradually introduced and the typical wire-grass association is reestablished. The succession is more rapid than that on short-grass land and the cycle is probably completed in from twenty to thirty years. One of the most interesting features is the introduction of many plants from the bunch-grass association and even of the true bunch-grass itself (*Andropogon scoparius,* fig. 15, p. 54) in the earliest stages of this succession. Breaking assists the deep-rooted plants to establish themselves by destroying the short-grass cover and allowing the water which would otherwise be absorbed by these grasses to become available to the deeper rooted plants. It is only after continued settling and puddling of the surface soil and the gradual entrance of the short grasses that the old conditions return and the short grasses are able to hold their own with deeper rooted plants, thus establishing the balanced condition which is characteristic of the wire-grass association.

Grazing.—The effect of grazing on land of this type is not very marked because none of the taller plants are eaten to any great extent by cattle and are injured only in so far as they are trampled.

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[a] Fungous diseases are at times of some importance in modifying the plant cover. The more important diseases which affect this association are those on the Psoralea-bush morning-glory, wire-grass, and grama grass. Psoralea suffers severely from *Aecidium psoraleae* Pk. and is often thinned out considerably. Another disease which is less destructive is *Parodiella perisporioides* (B. & C.) Speg. The bush morning-glory is also considerably thinned by *Albugo ipomoeae-panduranae* (S.) Swingle. The diseases of wire-grass (*Sorosporium consanguineum* Ell. & Ev.) and grama grass (*Puccinia bartholomaei* Diet.) are much less destructive but may have a slight effect in modifying the plant cover.

Excessive grazing often damages the short-grass cover, thus reducing the loss of water from the upper layers of the soil and enabling more of the deep-rooted plants to enter.

Fires.—Occurring, as they usually do, during the latter part of the summer, fires do not greatly injure old plants of Psoralea and the bush morning-glory, but the seeds are destroyed and propagation is thus checked. The wire-grass, however, is badly burned. Where fires are very frequent their tendency is to convert this type of vegetation into a pure short-grass cover.

VARIATIONS FROM THE TYPE OF THE WIRE-GRASS ASSOCIATION.

Being intermediate between the pure bunch-grass and the pure short-grass types, vegetation of the wire-grass association is found varying now in the direction of the one and now in the direction of the other. When it approaches a pure short-grass cover one or the other of the following conditions will be found to exist: (1) Either the land has become so impervious as to be in almost the same condition as the short-grass land, so that but few of the deep-rooted plants can obtain sufficient water for their requirements, or else (2) fires have completely destroyed the taller, deeper rooted plants. The evidence of fires is so unmistakable, however, that one can not easily be misled as regards this factor, the effect of which is, moreover, temporary. In an area of this type in which the deeper rooted plants have died out the old roots found in the deeper soil layers are a positive proof that the land was once occupied by the wire-grass association. Wherever the vegetation approaches a pure short-grass type owing to the impervious nature of the soil the vegetation and physical environment may be identical with that already described in the grama–buffalo-grass association under the headings "Wire-grass on short-grass land" (p. 47) and "Psoralea on short-grass land" (p. 46).

Wherever characteristic plants of the bunch-grass or of the sand-hills mixed association, such as sand sage (*Artemisia filifolia*, fig. 20, p. 64) and bunch-grass (*Andropogon scoparius*, fig. 15, p. 54), occur in the wire-grass association the indication is that the land is lighter in texture and is very similar to that characterized by those associations.

Sometimes the plant cover is very sparse, leaving a considerable percentage of the surface of the ground bare, although many different species of plants are present. This aspect of the wire-grass association is to be regarded as indicating conditions less favorable for agricultural purposes than where the vegetative cover is close and more or less uniform.

THE BUNCH-GRASS ASSOCIATION.

General Appearance.

The most extensive association on the sand hills of eastern Colorado is designated by the name of bunch-grass, which aptly describes its general appearance. As usually found in eastern Colorado, the clumps of bunch-grass are somewhat scattered, the spaces between being occupied by other plants. The general appearance of the vegetation is well shown in the accompanying illustration (Pl. IV, fig. 1). The considerable difference in the appearance of this association in different places is due largely to variation in the amount of bunch-grass present, but it can be recognized at any time of the year by the reddish-brown color of this grass. The vegetation appears much darker in color when looking against the wind than when looking in the direction the wind is blowing. In places where sand sage grows with the bunch-grass there may be a considerable variation of color.

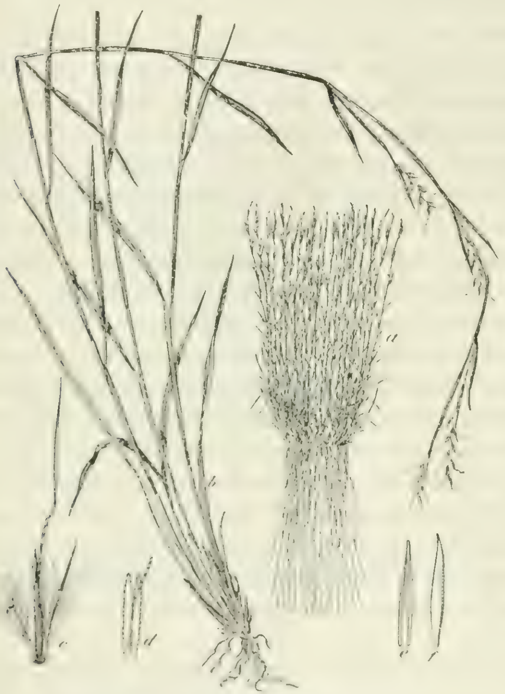

Fig. 15.—Bunch-grass (*Andropogon scoparius*), showing habit of growth, *a;* single plant, *b;* and details of spikelet, *c, d, e, f.*

The association in eastern Colorado is by no means as open as is commonly the case in Nebraska. The soil surface is occasionally well covered by an almost pure, close stand of bunch-grass, but more often by this grass mixed with other tall grasses and with short grasses occupying the interspaces. The soil is held so firmly that there is practically no blowing in land occupied by this association.

Botanical Composition.

The botanical composition of the bunch-grass association is somewhat varied. The plant which chiefly characterizes it is the bunch-grass (*Andropogon scoparius* Michx., fig. 15), but this grass is accompanied by a great many other species, of which the following are some of the most important:

Bouteloua hirsuta Lag.
Andropogon hallii Hack.
Calamovilfa longifolia (Hook.) Hack.
Aristida longiseta Steud.
Panicum virgatum L.
Psoralea tenuiflora Pursh.
Bouteloua oligostachya (Nutt.) Torr.
Artemisia filifolia Torr.

The bunch-grass often forms a dense growth, leaving room for few other plants. But usually the bunches are scattered (Pl. IV, fig. 1), and the interspaces are occupied by the other species above listed. As the bunch-grass becomes less dominant, conditions approach more and more nearly those found in the sand-hills mixed association (p. 58). In addition to the above all the species enumerated under the wire-grass association (p. 50) and the sand-hills mixed association may occur. To the description of the latter association especially, the reader is referred for a more complete list (p. 58) of plants that occur in the bunch-grass association.

PHYSICAL CONDITIONS INDICATED.

Where bunch-grass occurs we find a soil which contains moisture to a considerable depth. The bunch-grass itself is a deep-rooted plant, poorly adapted to absorb water from the surface soil. It is, accordingly, most commonly found on land where the bulk of the water supply lies below the first foot of soil. The greater number of the other plants found in this association have a similar root habit, but it also embraces many plants which utilize the water from the surface layers (fig. 16). Among the most important of these are the grama grasses, which here find a footing only in places not already occupied by the bunch-grass or other taller plants. All rainfall received by this type of land enters the soil and there is no run-off. The bunch-grass association in eastern Colorado occurs on a sandy soil [a] from which evaporation is relatively slow, owing to the rapid establishment of a surface mulch of dry soil after a rain. Where the water supply is sufficient an almost pure, dense cover of bunch-grass develops, but where the supply is less abundant the bunches are more scattered and there is a greater growth of short grass in the spaces between. The soil characterized by this association is not especially rich in plant food, but affords a better water supply than any other in the region.

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[a] With few exceptions the bunch-grass is limited in eastern Colorado to the sand hills. The exceptions are interesting. On banks where the soil is slowly falling down and where the water accordingly penetrates to considerable depths bunch-grass dominates even when the soil is a heavy loam. In the region of Bellefourche, S. Dak., bunch-grass was found on soil derived from the Fort Pierre shale, in places where the moisture conditions were especially favorable. Occasional clumps are found in heavy land in low places in eastern Colorado, where water stands for a short time after a rain. This species occurs quite commonly on clay or silt loam ridges and "breaks." In such places the soil is loose and is wearing away rapidly, the vegetation is scattered, and the conditions for water penetration are unusually favorable. It also occurs quite commonly on the gravelly soils near the mountains. Farther east, where the moisture conditions are more favorable, it grows on a loam soil (pp. 12 and 24).

Effect of Disturbing Factors.[a]

Breaking.—In eastern Colorado bunch-grass grows on a sandy soil. When such land is broken by plowing considerable blowing is likely to result. In fact, it often happens that a blow-out is established which will not be completely revegetated for very many years (Pl. VI, fig. 1). This, however, is not the most frequent course of events. Usually the land becomes covered after plowing with a growth of annual tumbleweeds, various Compositæ, amaranths, and the grass

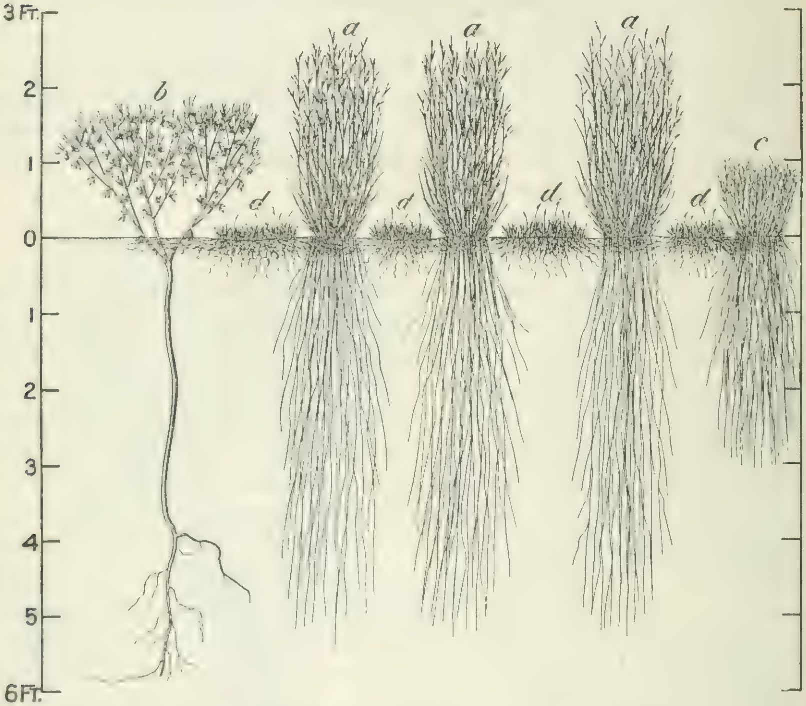

Fig. 16.—Sketch showing root distribution in the bunch-grass association. Bunch-grass, *a;* Psoralea, *b;* wire-grass, *c;* black grama, *d.*

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[a] Fungous diseases have little modifying effect on this association. *Puccinia andropogonis* S. occurs on *Andropogon hallii* and rarely on *A. scoparius*, but seems to do little damage. Psoralea, wire-grass, and bush morning-glory are sometimes badly parasitized. (See footnote, p. 52.)

Sporobolus cryptandrus. Plants from the sand-hills mixed association rapidly enter and the bunch-grass soon reestablishes itself. In general, we may state that the vegetation which follows breaking land of this character, when it is left without cultivation, corresponds to an historically earlier stage in the development of this association. If a blow-out occurs, the complete reestablishment of the bunch-grass may possibly require more than a century. If the more usual course is followed, the vegetation will in all probability return to the bunch-grass type in less than twenty years.

Grazing and fires.—Grazing alone does not materially modify this association when once well established. This is due to the fact that cattle do not eat the old bunch-grass. Fire, however, is a very important factor. The great mass of dry matter produced offers favorable conditions for the spreading of fires, which are often started by lightning. Burning injures the bunch-grass to such an extent that it does not fully recover for several years. The new growth is eaten by cattle, and as a result conditions are brought about which are favorable for the entrance of the short grasses. Under conditions of frequent fires and excessive grazing the short grasses become established on land which otherwise would be occupied by bunch-grass. This is a common condition inside the fire breaks along the railroads, in which places fires are frequent. Here bunch-grass is entirely replaced by short grasses, although the land just outside the breaks, where fires are much less frequent, may be completely dominated by bunch-grass.

VARIATIONS FROM THE TYPE OF THE BUNCH-GRASS ASSOCIATION.

Wherever the composition of the vegetation approaches very closely that of the wire-grass association (p. 48), it indicates a somewhat heavier type of soil, one which is by no means so likely to blow and yet retains its ability to take up water rapidly and to support the growth of deep-rooted plants. This land is, consequently, much more desirable for agricultural purposes than that of the pure bunch-grass type.

Wherever the growth of bunch-grass is unusually pure and dense, forming a close cover, it indicates a condition of favorable water supply, combined with rather high fertility, and is probably the most favorable type of bunch-grass land for general purposes of agriculture next to the variation toward the wire-grass association. The presence of the sand sage (*Artemisia filifolia*, fig. 20) and of the taller grasses (figs. 18 and 19) is very often associated with the occurrence of a more sandy soil and of conditions approaching those indicated by the sand-hills mixed association, which is discussed in the following section.

THE SAND-HILLS MIXED ASSOCIATION.

GENERAL APPEARANCE.

The great amount of variation found in the sand-hills mixed association (Pl. V, fig. 1) makes its general appearance rather difficult to describe. In general, it may be said to be dominated by taller growing grasses which often form large clumps several feet in diameter and which do not have the bunch-grass habit. Alternating with these are areas which are occupied by the grama grasses, *Bouteloua hirsuta* (fig. 17) being the most important, and by a great variety of taller plants other than grasses. The most characteristic feature of this vegetation is the presence of large and sharply alternating communities of the coarse-stemmed grasses, *Calamovilfa longifolia* (fig. 18) and *Andropogon hallii* (fig. 19), locally known, respectively, as "sand-grass" and "big bluestem."

BOTANICAL COMPOSITION.

The sand-hills mixed association shows great variation in botanical composition, as well as in general appearance. The following are the most important species:

Bouteloua hirsuta Lag.
Andropogon hallii Hack.
Calamovilfa longifolia (Hook.) Hack.
Artemisia filifolia Torr.
Aristida longiseta Steud.
Bouteloua oligostachya (Nutt.) Torr.
Psoralea tenuiflora Pursh.

Next to Calamovilfa and *Andropogon hallii*, sand sage (*Artemisia filifolia*, fig. 20) is the most noticeable plant. Bunch-grass (*Andropogon scoparius*) often occurs in this association, but whenever it becomes abundant the vegetation passes over to the bunch-grass association, which represents a much more stable type of vegetation.

The more open the vegetation the greater the number of species which are found. Almost everywhere there are species of secondary importance in great variety. The following list includes some of the more numerous of these plants:

Panicum virgatum L.
Ipomoea leptophylla Torr.
Yucca glauca Nutt.
Artemisia canadensis Michx.
Andropogon scoparius Michx.
Thelesperma gracile (Torr.) Gray.
Sorghastrum nutans (L.) Nash.
Chrysopsis villosa Nutt.
Bouteloua curtipendula (Michx.) Torr.
Liatris punctata Hook.
Cyperus bushii Brit.
Sideranthus spinulosus (Pursh) Sweet.
Ratibida columnaris (Sims) D. Don.
Artemisia gnaphalodes Torr. & Gray.
Petalostemum purpureum (Vent.) Rydb.
Eriogonum annuum Nutt.
Eriogonum effusum Nutt.
Sporobolus cryptandrus (Torr.) Gray.
Amorpha canescens Pursh.
Meriolix serrulata (Nutt.) Walp.
Stipa comata Trin. & Rupr.
Ambrosia psilostachya DC.
Hymenopappus filifolius Hook.
Evolvulus argenteus Pursh.
Helianthus petiolaris Nutt.
Tradescantia occidentalis Brit.
Andropogon furcatus Muhl.

PHYSICAL CONDITIONS INDICATED.

The soil on which the sand-hills mixed association occurs is usually a purer sand than that characterized by the bunch-grass association. It is a soil into which all of the rainfall penetrates, and in its water relations it is much the same as bunch-grass land. The conditions are, therefore, favorable for deep-rooted plants (fig. 21, p. 65). The danger of blowing is even greater here than on bunch-grass land.

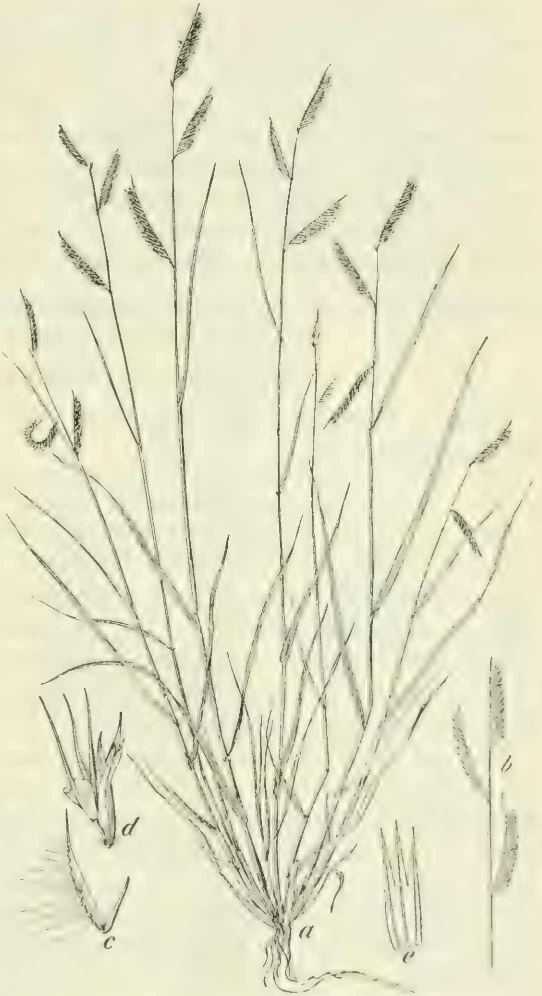

FIG. 17.—Black grama (*Bouteloua hirsuta*). Plant, showing habit, *a;* flowering spikes, *b;* empty glumes, *c;* perfect and imperfect flowers, *d;* flowering glume, *e*.

EFFECT OF DISTURBING FACTORS.

Breaking or plowing occasionally results in establishing blow-out conditions. When blow-outs do not develop, following breaking, and the land is left uncultivated the vegetation returns rapidly to the sand-hills mixed type. In the early stages of revegetation typical blow-out grasses (p. 60) quite commonly appear.

Fire and grazing are important factors in changing this type of vegetation. Grazing alone can alter this association much more than it can the bunch-grass vegetation, from the fact that all the important grasses are eaten by stock. One of the most marked changes thus produced is that the taller grasses are eaten down close to the ground, permitting the short grasses *Bouteloua hirsuta* (fig. 17) and *B. oligostachya* (fig. 2, p. 25) to develop. Grazing is especially favorable to the sand sage (*Artemisia filifolia*, fig. 20), which is not eaten by cattle, and upon the removal of the tall grasses and the consequent increase of moisture available in the deeper layers of the soil grows into unusually large plants. In this condition the appearance of the association is entirely altered (Pl. V, fig. 2).

VARIATIONS FROM THE TYPE OF THE SAND-HILLS MIXED ASSOCIATION.

This type varies on the one hand into the bunch-grass association and on the other into the blow-out association. (See below.) Wherever the natural vegetation is thin there is especial danger of blow-outs when the land is plowed, and in such places the plant cover should never be disturbed. Wherever the vegetation is dense this land offers fairly good conditions for crop production. The presence of a luxuriant growth of sand sage (Pl. V, fig. 2) with short grasses forming a close mat between the bushes also indicates conditions which are relatively favorable for crop production.

ASSOCIATIONS IN EASTERN COLORADO INDICATING NONAGRICULTURAL LAND.

THE BLOW-OUT ASSOCIATION.

Some of the most important plants that colonize blow-outs[a] (Pl. VI, fig. 1) are:

Redfieldia flexuosa (Thurb.) Vasey.
Psoralea lanceolata Pursh.
Muhlenbergia pungens Thurb.
Petalostemum villosum Nutt.

Any one of these sand-binding plants may form an almost pure cover or they may all occur in the same blow-out. These plants are usually followed by *Calamovilfa longifolia* (Hook.) Hack. (fig. 18), *Andropogon hallii* Hack. (fig. 19, p. 63), and many other species from the sand-hills mixed association.

The soil on which this association occurs is a pure, coarse sand. Below the dry surface mulch of 1 or 2 inches the soil is usually well supplied with moisture, the conditions for the conservation of a limited moisture supply being even more favorable than on summer-tilled land of a heavier type. When once a plant is established, conditions are favorable for growth. All of the plants here mentioned spread rapidly by rootstocks and runners and have very extensive root systems.

THE GUTIERREZIA-ARTEMISIA ASSOCIATION.

The vegetation of the Gutierrezia-Artemisia association is of an open, scattered type, leaving much of the soil surface bare. It is usually found where the surface of the ground consists of partly disintegrated rock (Pl. VI, fig. 2), and varies considerably in different portions of the Great Plains region. In the South it is characterized chiefly by *Gutierrezia sarothrae* (Pursh) B. & R. (fig. 22),[a] while farther north *Artemisia frigida* Willd. (fig. 23) becomes predominant. Except in the very earliest stages of the development of the association, *Bouteloua oligostachya* (fig. 2, p. 25) is always one of the most important elements. In the central regions the Artemisia and the Gutierrezia meet on almost equal terms. This vegetation indicates areas where water penetrates somewhat better than it does on pure short-grass land, but where, owing to the fact that the rock is not fully disintegrated into soil, the establishment of vegetation is taking place rather slowly. Such land is, of course, without agricultural value. This association includes most of the stages in succession from the first plants which appear after the disintegration of the rock commences to the final establishment of the pure short-grass cover. In its most

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[a] A typical blow-out is a large, crater-like area, often several hundred feet across, usually located in the top or side of a sand hill. The term is here used for all areas where sand is not held by vegetation and is consequently moving rapidly as a result of wind action.

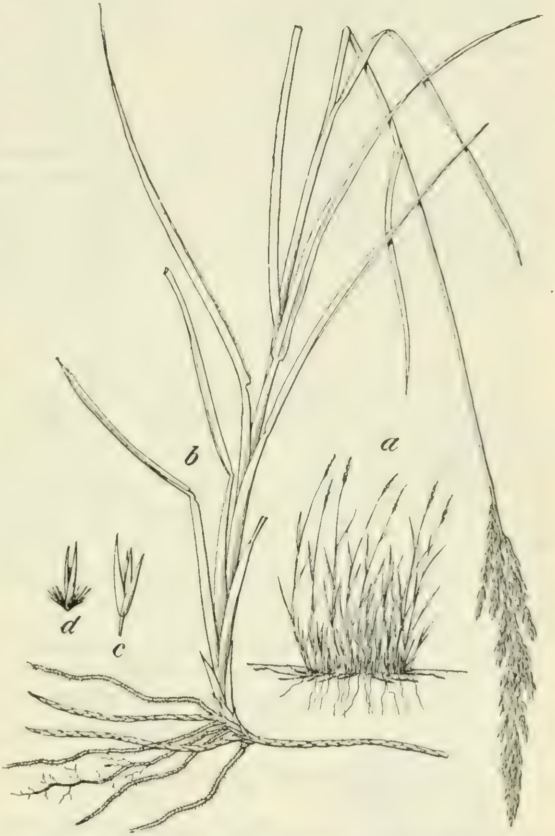

FIG. 18.—Sand-grass (*Calamovilfa longifolia*). Clump, showing habit, *a;* single plant, *b;* spikelet, *c;* spikelet with empty glumes removed, *d*.

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[a] An attempt to recognize in the field the many species that have been described in this genus leads to the conclusion that in some cases individual plants of different ages have been described as different species, and that some of these so-called species are produced merely by the operation of drought or of wet weather. On this account it seems best to follow Coulter and Nelson (New Manual of Rocky Mountain Botany, 1909, p. 489), who state concerning the forms most commonly found on the Great Plains that "It were better perhaps to consider them forms of this (*Gutierrezia sarothrae* (Pursh) B. & R.), as did Doctor Gray."

typical aspect it is characterized by the dominance of the two species for which it is named. A great many other plants are found in this association, among which are the following:

Actinella simplex A. Nels.
Eriogonum effusum Nutt.
Hymenoppapus filifolius Hook.
Eriogonum alatum Torr.
Paronychia jamesii T. & G.
Meriolix serrulata (Nutt.) Walp.
Psoralea tenuiflora Pursh.
Sideranthus spinulosus (Pursh) Sweet.
Chrysopsis villosa Nutt.
Eriogonum jamesii Benth.
Bouteloua curtipendula (Michx.) Torr.
Artemisia canadensis Michx.
Koeleria cristata (L.) Pers.
Lesquerella argentea (Pursh) MacM.
Astragalus sericoleucus Gray.
Grindelia squarrosa (Pursh) Dunal.
Oreocarya thyrsiflora Greene.
Actinella fastigiata (Greene) A. Nels.
Lithospermum angustifolium Michx.
Artemisia tridentata Nutt.
Malvastrum coccineum (Pursh) Gray.
Plantago purshii R. & S.
Opuntia polyacantha Haw.
Mentzelia nuda (Pursh) T. & G.
Petalostemum purpureum (Vent.) Rydb.
Yucca glauca Nutt.

THE LICHEN FORMATION.

On the Great Plains plants of the lichen formation occur only on rock outcrops and rock fragments. Their distribution is, therefore, limited. In its later stages this formation often passes into the Gutierrezia-Artemisia association and frequently persists even after the establishment of the short grasses. While this formation varies considerably in the species present in different portions of the Great Plains, in its appearance, at least, it is practically uniform. Important species in this lichen covering are:

Rinodina oreina (Ach.) Mass.
Lecanora calcarea (L.) Nyl.
Parmelia conspersa (Ehrh.) Ach.
Lecanora subfusca allophana Ach.

RELATIONSHIP OF THE DIFFERENT ASSOCIATIONS.

NATURAL SUCCESSIONS.[a]

All the associations thus far described are stages in one or the other of two great successions of vegetation. One of these begins with the appearance of lichens on the rock outcrops and ends with the full establishment of a pure short-grass cover. The other, beginning with bare sand on which plants of the blow-out association first appear, leads to the establishment of the sand-hills mixed association or of the bunch-grass association, and from either of these may pass on through the wire-grass association to a pure short-grass cover.

In the first succession the lichens become established on disintegrating rocks. As soon as the rock is broken down into finer particles and soil has been formed, plants of the Gutierrezia-Artemisia association (p. 60 and Pl. VI, fig. 2) begin to establish themselves, and gradually the land is occupied by this association. The presence of many rock fragments on the surface of the soil brings about a condition favorable to the downward percolation of water and unfavorable to its loss by evaporation. The greater number of the characteristic plants of this association are without surface-feeding roots, yet the conditions are favorable for the growth of the short grasses, and grama grass gradually becomes established. This shallow-rooted grass takes up much of the water in the surface layers of the soil, and consequently diminishes the supply which can penetrate to a depth where it becomes available to the deeper rooted plants of the Gutierrezia-Artemisia association. In the course of time the rock fragments become thoroughly disintegrated, forming a true soil, and the short grasses become dominant; the deeper rooted plants are slowly killed out and the pure short-grass vegetation is established.

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[a] See footnote, p. 19, for a definition of the term "succession."

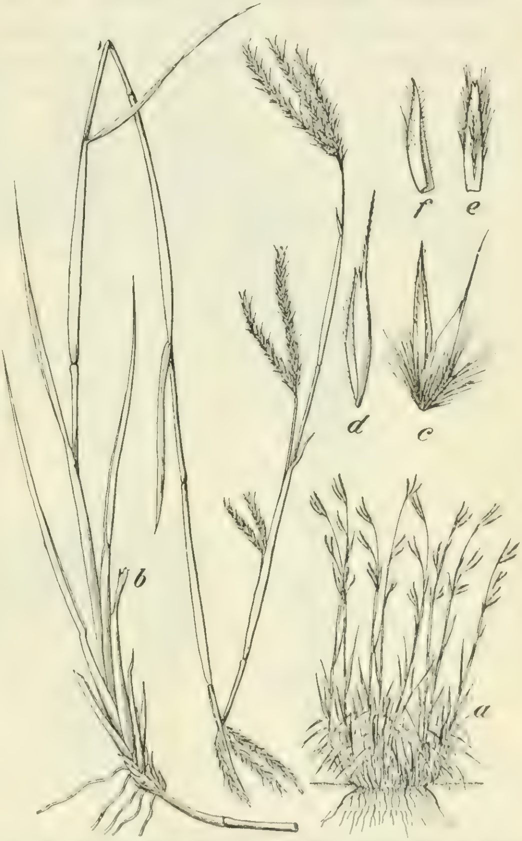

FIG. 19.—Big bluestem (*Andropogon hallii*). Clump, showing habit of growth, *a*; single plant, *b*; details of spikelet, *c*, *d*, *e*, *f*.

The succession which begins with the blow-out is much more complex. The moving soil is first held by plants which constitute the blow-out association (p. 60). This gives way to the sand-hills mixed association (p. 58 and Pl. V, fig. 1) without the intervention of any factors other than the appearance of the plants themselves and the resulting increased stability of the soil. The vegetation may remain in this condition for a long period or it may pass over into one of the modifications of the sand-hills mixed association (p. 60 and Pl. V, fig. 2), or it may gradually give place to the bunch-grass association (p. 54 and Pl. IV, fig. 1).

It is probable that without the intervention of fires or of grazing the succession would usually end at this point. But the intervention of these factors is likely to produce still further changes. The effect of frequent fires may in time change the vegetation from bunch-grass to short grass, or this result may be accomplished through the influence of grazing. The transition often takes place through the intermediate wire-grass association (p. 48 and Pl. I, fig. 2).

In a general way we may say that from the lichen formation on undisintegrated rock the vegetation passes gradually through a number of well-marked stages to the short-grass cover, and that from the first vegetation on bare sand soil (for example, in blow-outs) it passes through an even greater number of stages to the bunch-grass cover. By the aid of fires and grazing this bunch-grass cover in time often passes over gradually to the pure short-grass type.

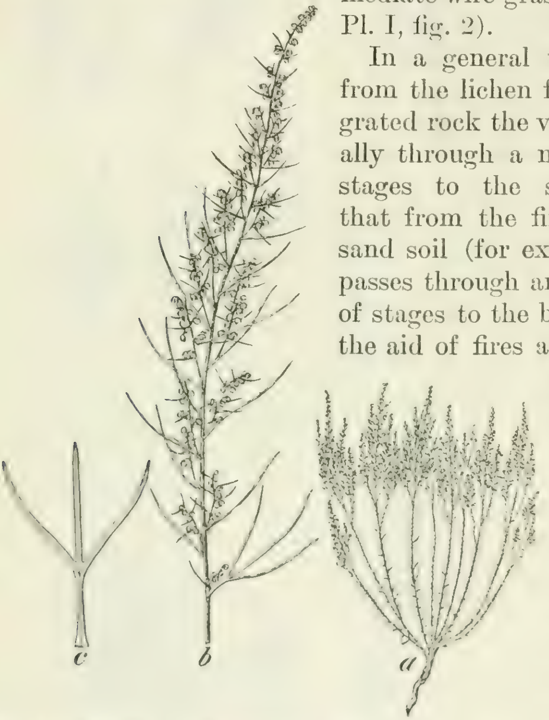

Fig. 20.—Sand-sage (*Artemisia filifolia*). Single plant, *a;* flowering branch, *b;* leaf, *c.*

Still another succession should be mentioned. Where the rocks which disintegrate are sandstone the vegetation which establishes itself after the lichen formation is not the Gutierrezia-Artemisia association, but a wire-grass or a bunch-grass vegetation. If the soil formed is exceedingly sandy, the bunch-grass vegetation may become permanently established. If, however, the soil is less sandy, wire-grass vegetation will first become established, and this will be followed gradually by pure short-grass cover.

We see, then, that short-grass vegetation represents the final stage of three different successions: First, that beginning with the lichen formation and passing through the Gutierrezia-Artemisia association; second, that beginning with the lichen formation and passing through the bunch-grass and the wire-grass associations; third, that beginning with the blow-out and passing through the sand-hills mixed association, and, with the aid of fires or of grazing, through the bunch-grass and the wire-grass associations.

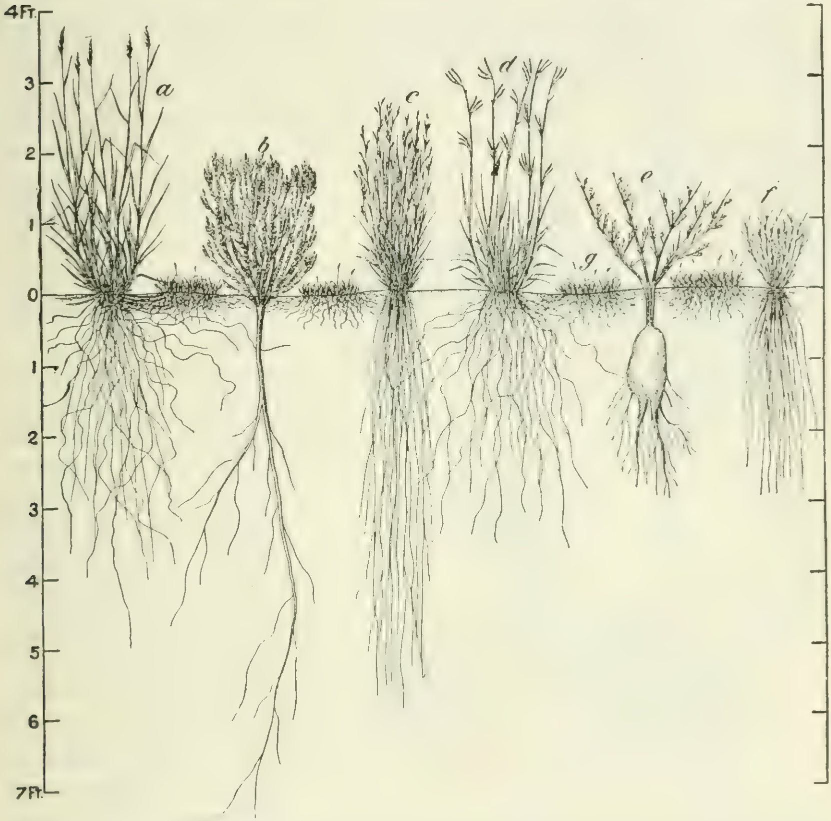

FIG. 21.—Sketch showing root distribution in the sand-hills mixed association. Sand-grass, *a;* sand sage, *b;* bunch-grass, *c;* big bluestem, *d;* bush morning-glory, *e;* wire-grass, *f;* black grama, *g.*

SUCCESSIONS DUE TO THE INTERVENTION OF MAN.[a]

The successions due to the intervention of man are of importance in this connection from two points of view. In the first place they show to what extent damage is done to the native pasture or range by breaking.[a] In the second place they throw much light upon the way in which the natural successions must have taken place, and hence their study has contributed greatly to a more complete understanding of the present structure of the different associations and what they indicate as to environmental conditions.

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[a] See footnote, p. 19.

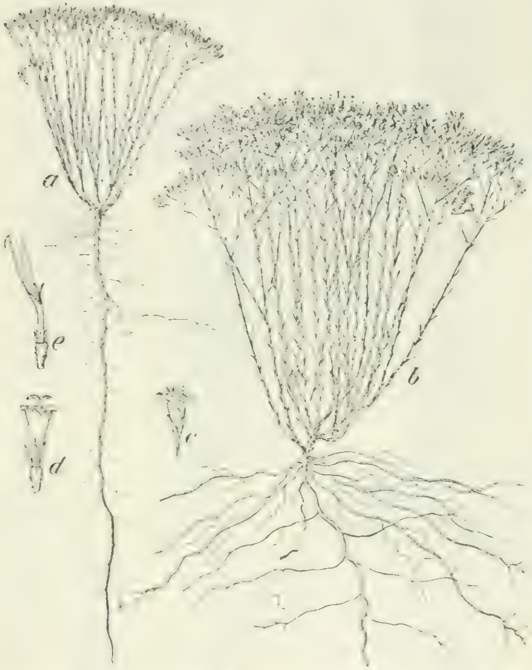

FIG. 22.—*Gutierrezia sarothrae.* Young plant showing deep taproot, *a;* old plant showing better development of lateral roots, *b;* flower head, *c;* disk flower, *d;* ray flower, *e.*

Wherever short-grass land is broken (p. 40) and then abandoned it is first covered by a growth of weeds, after which the type of vegetation that immediately preceded the short grass in this particular place regains possession. If, for example, we break short-grass land which has been derived from the Gutierrezia-Artemisia association and consequently offers conditions favorable to that association the land will become occupied by the latter association (Pl. II, fig. 1). The Gutierrezia-Artemisia vegetation will in turn gradually give way to the short grasses, which will be fully reestablished within a period of thirty to fifty years. An area of short-grass land in which the physical conditions approach more nearly those of wire-grass land, if broken, will be possessed after the preliminary weed stage by plants of the wire-grass association (Pl. II, fig. 2), and will then gradually return to the short grasses, the time required being twenty to forty years.

Breaking done on wire-grass land (p. 52) will result in the establishment of a vegetation such as usually characterizes a still lighter type of soil. Many plants from the bunch-grass and the sand-hills mixed associations enter, and in the early stages of this succession bunch-grass itself quite generally occurs. The vegetation will ordinarily return to the wire-grass type in fifteen to thirty years.

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[a] If wheat-grass is abundant, breaking often improves the range, but as a rule the range is damaged.

Wherever land characterized by the bunch-grass (p. 54) or the sand-hills mixed associations (p. 58) is broken a blow-out (p. 60 and Pl. VI, fig. 1) may result. This, however, is unusual, although there is great danger if the land is plowed in the fall of the year. Usually the weed stage is most prominent the first year or so, but the native grasses soon regain possession and the succession is completed in a much shorter time than on the heavier types of land.

It will thus be seen that when the vegetation of each of the plant associations is destroyed by breaking it will be followed, after the weed stage, by vegetation characteristic of a lighter type of soil, and also that this vegetation is that characteristic of an earlier stage in the natural succession.

A knowledge of the conditions indicated by these secondary successions which result from breaking is a useful guide in estimating the comparative value of land. For example, short-grass land which when broken reverts to wire-grass should be regarded as much more favorable for agricultural purposes than short-grass land which when broken becomes occupied by Gutierrezia and Artemisia.

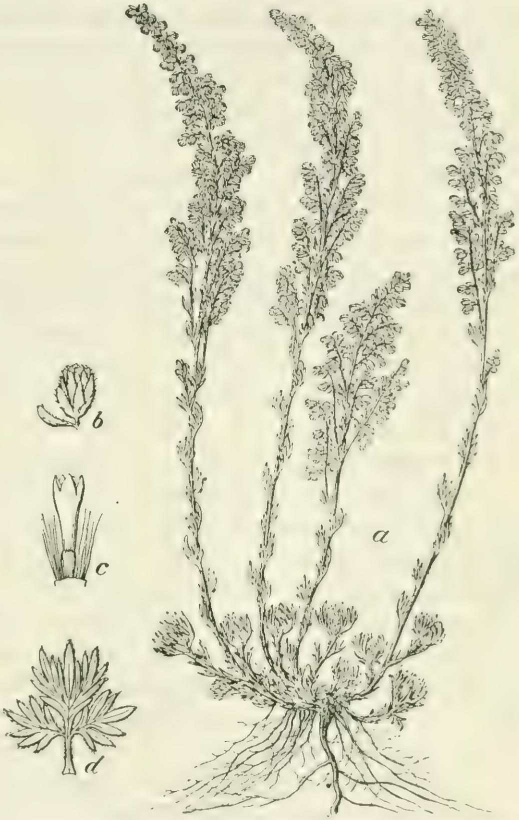

FIG. 23.—*Artemisia frigida.* Plant, showing habit, *a;* flower head, *b;* single flower, *c;* leaf, *d.*

PLANT COMPETITION AND THE REASONS FOR THE SUCCESSIONS.

The successions brought about by breaking are probably due entirely to the changed physical conditions. The destruction of the entire surface vegetation by plowing brings about a condition which is much more favorable for the storage of water in the soil than previously existed. Repeated observations in the field show that after a rain the water penetrates much deeper on land that has been broken than on that covered by the undisturbed native sod. This increase in the depth of penetration is brought about partly as a result of the great reduction in the quantity of plant growth and the consequent higher water content of the soil previous to the rain and partly as a result of decreased run-off on the broken land as compared with the native sod.

Breaking destroys the vegetation almost entirely, thus leaving the area open for the entrance of new plants. Naturally, the annual weeds, with their exceptional ability to seed new land and to grow rapidly at almost any period of the year when temperature and water content are favorable, are first to appear. The species which may enter into this stage are so numerous and their appearance is so dependent upon the chances of a supply of seed being near at hand that this stage of the succession has been passed over with very little discussion.[a]

If after short grass is turned under the Gutierrezia-Artemisia type of vegetation becomes established it is probable that in the deeper layers of the soil conditions are more favorable for the growth of deep-rooted plants than they were previous to breaking. The subsequent reestablishment of the short grasses on such land and the resulting disappearance of the Gutierrezia and Artemisia are likewise results of changes in the physical condition. The surface soil gradually becomes hard again and somewhat puddled, resulting in decreased water penetration and increased run-off. Measurement of the rate of penetration shows a great increase when the surface of soil of this character is loosened or removed. Another condition which is of great importance here is the direct competition for water between the short grasses and the deeper rooted plants of the Gutierrezia-Artemisia association. Many of the latter, such as Actinella, Eriogonum, etc., have practically no surface roots. As the short grasses gradually enter, their shallow roots have the first chance at the moisture, which after a rain is held for some time in the surface layers of the soil and passes but slowly to deeper layers (p. 33).

The younger plants of Gutierrezia have a very deep tap root and almost no lateral roots (fig. 22, *a*, p. 66). The short grasses are consequently able to kill out this plant by consuming the available water before it can reach the roots of the Gutierrezia. This condition comes about gradually, however, and many of the older Gutierrezia plants will be found to maintain themselves for a long period in the short-grass cover. But an examination of the roots of such plants will show that the root habit has become greatly changed (fig. 22, *b*). Many lateral roots have developed which feed largely in the surface layers of the soil and are in this way able to compete with the roots of the short grasses. The long season required for Gutierrezia to complete its development and ripen seed is probably one of the reasons why, notwithstanding its ability to modify its root system, it does not succeed better in competition with the short grasses.

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[a] See footnote, p. 41.

When wire-grass vegetation becomes established upon short-grass land that has been broken the plants of this association are likely to dominate for a number of years. But the cover is never very close, and in the interspaces the short grasses soon become established. Wire-grass is deep rooted and feeds in layers of the soil lower than those which sustain the short grasses. The wire-grass is gradually shut out by the short grasses, which absorb the water in the surface layers, leaving little or none for deeper rooted plants. It is clear that with a limited water supply the short grasses, having roots which completely occupy the surface soil, are able to drive out the deeper rooted plants with which they come into competition.

Wire-grass land affords a good illustration of a balanced condition—a condition of continual stress between the short grasses and the deeper rooted plants (fig. 14, p. 51). The fact that water is available in the deeper layers of the soil is demonstrated by the presence of many deep-rooted plants on this land, and it might be supposed that under these conditions bunch-grass would take possession. But in this connection we should consider that bunch-grass requires a long season, approximately one hundred and fifteen days, to complete its growth, while wire-grass requires only about forty days to ripen seed. Even *Psoralea tenuiflora* (fig. 12, p. 46), which is one of the long-season plants of the wire-grass association, requires only about eighty days. In the wire-grass areas there is less water in the deeper layers than on bunch-grass land, and it is in all probability exhausted much earlier in the season. The plants of short-grass land are, as a rule, short-season plants, grama grass requiring sixty days to mature, while buffalo grass requires only about thirty-six days. The plants of the wire grass association are intermediate in length of season. Bunch-grass and many of the species associated with it require a long growing period, and a sufficient water supply is necessary throughout the summer.

The behavior of the native vegetation indicates clearly that the conditions favorable for growth on short-grass land last for only a comparatively short season, beginning with the spring rains and extending to about the middle of summer. The more important plants of this association can mature in sixty days or less and many of them in less than forty days. On wire-grass land the season is somewhat longer, while on bunch-grass land it is almost twice as long, the principal species requiring considerably over one hundred days to mature seed.

The physical conditions on bunch-grass land are favorable for the development of wire-grass and of the short grasses as well as of bunch-grass. The two former are kept down by direct competition, by being shaded by the taller bunch-grass. The physical conditions on wire-grass land are favorable for the short grasses, and these are kept down in the same way by the wire-grass. On the other hand, the physical conditions encountered on the short-grass land are decidedly unfavorable for bunch-grass and often for wire-grass as well.

Grazing and fires bring about conditions which are especially interesting from the standpoint of plant competition. Working together they keep down the bunch-grass and similar tall-growing species, thus allowing the short grasses to maintain themselves notwithstanding the fact that the other conditions are favorable for the growth of deep-rooted plants. The effect of close grazing on land occupied by the sand-hills mixed association (Pl. V, fig. 1), which often results in establishing a pure short-grass vegetation between the plants of sand sage, offers a most interesting example of this condition. The sage, which is not eaten, develops into large bushes, owing, doubtless, to the fact that it has no competitors for the water in the deeper layers of the soil. The short grasses also grow well on such land, since the taller grasses are kept down by grazing and can not displace the short grasses by overtopping them.

CROP PRODUCTION ON LAND CHARACTERIZED BY DIFFERENT TYPES OF VEGETATION.

CROP PRODUCTION ON SHORT-GRASS LAND.

PHYSICAL CONDITIONS OF CULTIVATED SHORT-GRASS LAND.

The physical conditions indicated by the presence of short grasses have already been discussed on pages 27 to 40. The water supply available for the plant is greatest in June and rapidly decreases in July, August, and September. The native plants, almost without exception, require only a short growing season. In eastern Colorado land characterized by short-grass vegetation is a loam which will easily take up 25 per cent of the water after a rain. The water penetrates slowly, and as a result of the ability of the soil to hold a high percentage moisture is usually confined to the upper foot or two of soil. Wherever the land is kept free from vegetation, as in summer tillage without crop, loss of water is greatly retarded and water may be conserved for a fall crop.

WATER PENETRATION.

Measurements were made to determine the comparative penetration and run-off from cultivated land and from the native sod, care being taken to avoid low places or places where there was a perceptible slope.[a]

On September 3, after a rainfall of 1.12 inches, very careful measurements were made at the Akron Dry-Land Experiment Farm, on 6 corn plats, 1 kafir plat, and 1 summer-tilled plat. The corn plats were all well cultivated and had received various treatments previous to spring planting to corn. The conditions represented a wide range of soil management and should, therefore, have given good averages. Each measurement was based upon three carefully selected samples which were chosen in places of average water penetration as shown by the depth to which the dark color of the moist soil extended. This rain was of a torrential character and conditions were most favorable for a high rate of run-off. The run-off at the base station in the short-grass land, where the records of soil-moisture content were taken twice daily throughout the season, was the greatest recorded during the whole period. The comparative results are given in Table X.

TABLE X.—*Penetration and run-off for short-grass sod and cultivated land at Akron, Colo., as a result of a 1.12-inch rain, September 3, 1909.*

Description of land.	Penetration.	Run-off.
	Per cent.	*Per cent.*
Short-grass sod at base station	45	55
Average for 8 cultivated plats	51	49

From these results, as well as from those recorded in another publication,[b] it is evident that run-off is a factor of great importance.

The data here given show that the run-off on cultivated land was very great, in fact, almost as great as on the short-grass sod.

As a result of the heavy rain of 2.39 inches on July 7, the comparative data following were obtained.

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[a] The penetration and run-off on land covered with short-grass vegetation are discussed in detail on p. 34.

[b] Briggs, L. J., and Belz, J. O. Dry Farming in Relation to Rainfall and Evaporation. Bulletin 188, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910, p. 15.

TABLE XI.—*Penetration and run-off for short-grass sod and summer-tilled plat, at Akron, Colo., as a result of a 2.39-inch rain July 7, 1909.*

Description of land.	Penetration.	Run-off.
	Per cent.	*Per cent.*
Short-grass sod at base station	86	14
Summer-tilled plat	48	52

This high percentage of run-off from summer-tilled land accords with the results of previous measurements.[a] Many observations in the field show that the penetration of rain water into a dust mulch, such as is often maintained on a summer-tilled field, is very slow, and that this mulch is almost as effective a preventive of water penetration as of evaporation. On the other hand, observations of the penetration on newly plowed sod and on lumpy, cultivated land show that when the surface is in a rough condition water enters rapidly. It is desirable, especially during the rainy season, to have the soil in such condition as to prevent run-off as far as possible, and to develop a dust mulch only when the soil is already well supplied with water.

BEHAVIOR OF CROP PLANTS.

Because of the fertility of the soil, cultivated crops on short-grass land usually produce a luxuriant growth in the spring and early summer. The water supply, although high enough in percentage, does not extend to any considerable depth and the crop is in very much the same condition as that of potted plants where, although the water supply is sufficient temporarily, it is soon exhausted by rapid growth and the plant is suddenly left with no reserve. The very rapidity and luxuriance of the early growth exhaust the water supply all the more rapidly, and the fact that the water is limited to a shallow surface layer of soil means that loss by direct evaporation is relatively high. During the latter part of July conditions are almost sure to occur which will cause a sudden drying up of the crop. This condition takes place so suddenly that it is practically impossible for any crop to adjust itself rapidly enough to meet this change. Corn is especially liable to be destroyed at this critical period, for it possesses little ability to recover after drought. Wheat crops, particularly the fall wheats, may be ripened before the period of drought comes on, but this does not always happen, and in especially unfavorable years even the small grains will be an entire failure. On the other hand, during wet years or years in which a moderate rainfall is unusually well distributed, crop production on short-grass land is greater than on any other type of land in eastern Colorado.

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[a] Briggs and Belz, op. cit., p. 15. The comparatively low percentage of run-off at the base station has already been discussed. (See p. 34.)

The frequent failures of crops on short-grass land are largely due to lack of sufficient rainfall or to its unequal distribution. Another reason is the fact that during torrential rains by no means all of the rainfall is stored in the soil, a great amount running off, while that which enters the soil remains near the surface and is rapidly lost by evaporation. A further point of importance is that because of the abundance of plant food the crop often grows too luxuriantly in the beginning and consequently uses up at too early a period in its growth the moisture which should have sufficed for the entire season.[a] Under these conditions a field of wheat which produces a good stand of straw may produce no grain, the excessive growth of straw having exhausted the water supply before the grain could ripen. The same is true of other crops, especially corn, which often dries out just at the period of earing. In this connection it is interesting to note that in this region when land is manured the resulting stimulation of growth almost always exhausts the water supply too rapidly. Hence a general impression prevails throughout the Great Plains region, based on actual experience, that manure will cause a crop to burn up; and it is, therefore, only rarely used. These facts make it necessary that the importance of thin seeding be emphasized. Where too many seeds are planted the crop uses up the total water supply before any of the plants mature. Thin planting, on the other hand, leaves a greater water supply for each individual plant. These facts also indicate that dwarf strains are better adapted to short-grass land than the larger and more luxuriant varieties.

Reference to the rainfall records for eastern Colorado (p. 28) will show that during average years the water supply decreases rapidly from July to November. The increased heat in July and August makes this a period of the year when drought is to be expected. The natural plant cover consists chiefly of species that complete their growth by the middle of July. These conditions of climate and soil, illustrated by the behavior of the native vegetation, show that short-grass land is best adapted to what might be termed "early-season crops"—crops which mature early in July. The production of later crops during average years is more or less uncertain because of the tendency for drought to occur after the middle of summer. Among the most successful later crops are sorgo, milo, etc., which by their slow growth during the early season conserve the soil moisture and on this account are enabled to continue growth longer than other crops which rapidly exhaust the soil moisture.

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[a] See Chilcott, E. C., "A Study of Cultivation Methods and Crop Rotations for the Great Plains Area," Bulletin 187, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910, p. 19.

Under natural conditions short-grass land is not at all adapted to deep-rooted crops, and clean cultivation is required to establish conditions favorable for such plants. Tillage on short-grass land always produces more favorable water relations by conserving the moisture which enters the soil.

Many timber claims are found in eastern Colorado, but few of them occur on short-grass land. Yet in some places trees have done surprisingly well on such land. While these trees grow on land which was previously covered with the short grasses, the land on which the trees stand now produces wire-grass, as a result of the breaking done when the trees were planted. On this hard type of land the most successful trees seem to be the ash and the box elder, although many other species, especially the elm, hackberry, and honey locust, have grown fairly well.

With clean cultivation and with the trees set far apart, orchards of apple, plum, cherry, pear, and peach trees have been established in several places. The most successful tree growth, however, occurs in land where wire-grass or Psoralea, or both, are rather abundantly mixed with the short grasses. Such trees as willow and cottonwood are not at all adapted to the conditions existing on short-grass land.

Under conditions such as these there seems little to justify the assumption that alfalfa will last for many years on short-grass land, even if a stand can be secured. It is a very deep-rooted plant and not at all adapted to the conditions above described. That water supply is the principal limiting factor should always be borne in mind in considering crop production in this region. A field of rapidly growing alfalfa such as may be seen in irrigated sections would exhaust the total water supply of the soil in a few days. Yet it is possible that alfalfa, when not too thickly seeded or, preferably, planted in rows or hills with intertillage, can be made a profitable crop on short-grass land.

The impression that a very large yield can be obtained provided especially adapted crop plants be grown also seems unfounded, for with the limited water supply even the native plants and weeds never produce a great amount of dry matter in a single season (p. 81). The best estimates obtainable as to the amount of water required to produce a pound of dry matter make it probable that with the average seasonal rainfall of eastern Colorado it would be impossible to produce more than 3 tons per acre, even if no water were evaporated directly from the soil and there were no run-off.

CROP PRODUCTION ON WIRE-GRASS LAND.

PHYSICAL CONDITIONS OF CULTIVATED WIRE-GRASS LAND.

The physical conditions on wire-grass land (p. 50) are very different from those of short-grass land (p. 27). The soil, being of a much lighter texture, absorbs practically all the rain that falls upon it and permits the moisture to penetrate to greater depths. Consequently there is a bed of moist soil extending to a depth of several feet. The presence in the native vegetation of many deep-rooted plants indicates this condition. Under cultivation it is probable that water penetrates still more easily than under natural conditions. Furthermore, the loss of water by evaporation is retarded to a very great extent by cultivation. As a result we find here a condition very favorable for the production of crops either shallow or deep-rooted.

Since water is distributed to considerable depths in this type of soil, the exhaustion of the water supply in the immediate vicinity of the roots is not necessarily fatal to the plant, for there is a large area of moist soil into which roots can penetrate or from which water can move slowly to where it is within reach of the root systems, and this area serves as a reserve in time of drought. The loss of water by evaporation after a rain is not so great on wire-grass land as on short-grass land and the conditions for the conservation of the water supply through the whole season are much better.

BEHAVIOR OF CROP PLANTS.

Taking one year with another, wire-grass land is the best in the region for agricultural purposes. The yield in wet years is almost equal to that of the short-grass land and during the average year it is much better. Often when crops fail entirely on short-grass land wire-grass land will produce good crops. The conditions on land of this type are such as to favor deep-rooted crop plants. It is believed that alfalfa, especially if planted in rows or hills and not too close together, will here find excellent conditions for its growth.

Successful tree claims are more numerous on this type of land than on land of any other type. Among the species that succeed best are the elm, ash, box elder, black locust, and honey locust. The finest grove of trees seen by the writer in this portion of the Great Plains was on this type of land at Cope, Colo. Cottonwood and poplar, as well as a great variety of fruit trees, were growing successfully in this grove. There is a possibility that at this place the trees are subirrigated by water that seeps down from the sand hills, yet this seems unlikely, for during the latter part of the summer of 1909 many of the trees in this plantation, especially those which were in competition with the grasses, suffered so severely from drought that their foliage was badly wilted. If subirrigation were taking place, this would hardly have occurred, for many of the trees in places known to have no subirrigation were in better condition, although subjected to the same drought.

In general, it may be stated that on wire-grass land the water penetrates to a considerable depth and that the conditions are very favorable for the development of deep-rooted plants. The effect of cultivation on moisture conservation is not so great as on short-grass land, but is still rather marked. The degree to which the soil texture favors the penetration and conservation of water makes this land the best type for agricultural purposes found in eastern Colorado. Under the same climatic conditions crops will mature easily on this type of land when on short-grass land they are entirely burned.

CROP PRODUCTION ON BUNCH-GRASS LAND.

PHYSICAL CONDITIONS OF CULTIVATED BUNCH-GRASS LAND.

The physical conditions indicated by bunch-grass vegetation (p. 55) are those most favorable for the growth of deep-rooted plants. In eastern Colorado this vegetation indicates a sandy soil in which water penetrates very readily and to great depths. The cultivation of this soil does not materially facilitate water penetration nor diminish the rate of water loss. We have under natural conditions a water relation which is most favorable for the growth of plants (Pl. IV, fig. 2) with deep and extensive root systems.

BEHAVIOR OF CROP PLANTS.

During wet years the ease with which water percolates makes it practically impossible for the soil to become too moist for the best growth conditions. During dry years growth is slow on this type of land, and as a consequence the water is only slowly exhausted by the plants. Because of the great depths to which water penetrates and is stored in the soil, plants are able to continue growth during a long period of drought by the gradual extension of their root systems. Under the same climatic conditions bunch-grass land can produce a fair crop when water is entirely lacking in short-grass land. In fact, the bunch-grass land during excessive drought is the best type for crop production, but during average years it is considerably inferior to wire-grass land, largely because the latter is richer in plant food. In a series of pot experiments, soil from short-grass land produced much the best growth, wire-grass land ranked next, bunch-grass land next, soil from the sand-hills mixed association next, while soil from the blow-out association produced the least growth. This is directly in accordance with the production of crops under field conditions when each type of soil is well supplied with water.

Bunch-grass land has the further disadvantage of being liable to blow badly. Hence very little attempt has been made to utilize this land for small-grain crops. The most successful crops have been corn, sorgo, milo, etc.

In eastern Colorado land of this type and that of the wire-grass type is often referred to as "corn land," since by far the greater yield of this crop is produced on farms which are on either bunch-grass or wire-grass land. During the falls of 1907 and of 1908 many good fields of corn were seen on bunch-grass and wire-grass land, while on the adjacent short-grass land the crop was an entire failure.

Trees of many different kinds are commonly grown on bunch-grass land. The cottonwood, willow, Carolina poplar, soft or silver maple, walnut, catalpa, ash, elm, box elder, honey locust, black locust, cherry, apple, plum, Russian mulberry, etc., make a good growth on land of this type, and even on land marked by the sand-hills mixed vegetation (p. 58), and occasionally by the blow-out type (p. 60 and Pl. VI, fig. 1) of vegetation. Conditions on bunch-grass land are favorable for deep-rooted crops, such as trees and alfalfa. Very successful fields of alfalfa are here and there found, especially where it has been seeded in rows and where other plants are not allowed to compete with it for the soil water.

PRECAUTIONS NECESSARY IN HANDLING BUNCH-GRASS LAND.

Ordinary moisture-conservation methods of tillage should never be practiced on bunch-grass land, since nothing is to be gained and there is every chance of loss due to blowing. As a result of many observations in the field, the following methods are suggested:

(1) The land should be laid out in long narrow fields running east and west.[a]

(2) The crops should be so arranged that two adjacent fields are not prepared for seeding at the same time and the soil in both thus left without protection.

(3) Because of the value for hay of the natural growth of grasses occasional or even alternate fields may be left undisturbed for this purpose.

(4) By proper care in arranging the crops those which do not afford a sufficient cover to prevent the soil from blowing can be protected by adjacent crops which do prevent soil movement.

(5) When practicable, as much of the straw or stubble should be left on the field as will be necessary to prevent blowing during winter and early spring.

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[a] As indicated by the blow-outs the winds which do the most damage are from a little west of north and a little east of south, hence approximately at right angles to narrow fields running east and west.

(6) Since cultivation does not noticeably increase water conservation, only such cultivation should be done as is necessary to keep down weeds.

(7) When practicable, cultivation should be done only when the surface soil is damp.

(8) If the soil has begun to blow, cultivation deep enough to bring moist soil to the surface will often check it.

(9) Care should be taken to avoid breaking the native sod on crests or hilltops.

(10) Corn, sorgo, milo, and deep-rooted crops, especially perennials, such as trees and alfalfa, should be tried.

A COMPARISON OF THE CONDITIONS INDICATED BY SHORT-GRASS, WIRE-GRASS, AND BUNCH-GRASS VEGETATION.

THE SOIL-MOISTURE RELATIONS INDICATED.

In comparing the conditions found on short-grass, wire-grass, and bunch-grass land, respectively, in the limited area especially considered here, we find that they are largely expressed in the different water relations of the different soils. The rates of water penetration as measured on these three types of land under the same climatic conditions during the summer of 1909, and also comparisons of typical samples of these soils as to other water relations—moisture equivalent and nonavailable soil moisture for Kubanka wheat—are given in Table XII.

TABLE XII.—*Comparison of water relations of short-grass, wire-grass, and bunch-grass land.*[a]

Item of comparison.	Short-grass land.	Wire-grass land.	Bunch-grass land.
Time required for one-half inch of water to penetrate......seconds..	540	150	40
Moisture equivalent....................................per cent..	18.1	9.7	4.7
Nonavailable moisture for Kubanka wheat..................do....	9.6	4.8	2.6

[a] See footnote, p. 18, for a definition of the terms "moisture equivalent" and "nonavailable moisture." It will be noted that the nonavailable water content bears a practically constant ratio to the moisture equivalent for these three types of soil. This relationship has been under investigation during the past two years by Dr. L. J. Briggs and the writer, and will be fully discussed in a publication now in preparation.

Since these soils weigh approximately 84, 93, and 96 pounds, respectively, per cubic foot, we can estimate the depth of penetration of any given amount of rainfall, provided we know the water content of the soil before and after the rain. We may assume, for the sake of illustration, that the water content of the soil before the rain is the nonavailable moisture for Kubanka wheat, and after a rain that the water content is equal to the moisture equivalent. The depth to which water would penetrate in the different soils under these conditions, provided none were lost by run-off or immediate evaporation, is shown in Table XIII.

TABLE XIII.—*Estimated depth of water penetration, assuming that the water content of the soil to the depth of penetration is raised by the added moisture from the nonavailable moisture to the moisture equivalent.*

As a result of—	Depth of penetration in inches.		
	Short-grass land.	Wire-grass land.	Bunch-grass land.
One inch of rain	8.7	13.7	30.9
The average seasonal rainfall, April to July, 10.35 inches	90	142	320

Differences in the depth of moisture penetration are to a great extent the causes of the differences in the ability of crops to resist drought on land of the different types. Where the moisture is held near the surface it is not only more readily lost by direct evaporation but can be rapidly exhausted by the plants, whose roots reach to every part of the moist layer of the soil. Where the water is distributed to greater depths it is not only less readily lost but can not be exhausted so quickly by growing plants.

It should be noted that streams originating in the sand hills are permanent and do not dry up during periods of drought. This indicates that water is lost by percolating beyond the reach of the plant roots. However, the amount which is lost in this way is probably almost negligible as compared with that dissipated by evaporation and transpiration.

In this region the soils are often very dry in the fall of the year and continue so until early spring. From repeated measurements the data in the first column of figures of Table XIV are given as the approximate water content of the top foot of soil at the end of the dry season just before the spring rains begin.

It will be seen from the figures in Table XII and the first column of figures in Table XIV that something more than the quantity of water shown in the three right-hand columns of Table XIV must be added to each soil before any will become available for the plant.

TABLE XIV.—*Water status at end of dry season for three kinds of soil.*

Kind of soil.	Percentage of water present in surface foot of soil.	Maximum percentage and quantities of water which can be added before any will become available to the plant.		
		Percentage.	Pounds of water per cubic foot of soil.	Inches of water per foot of soil in depth.
Short-grass land	5.0	4.6	3.86	0.74
Wire-grass land	2.7	2.1	1.95	.37
Bunch-grass land	1.3	1.3	1.24	.24

From the above data it is evident that in this region of deficient rainfall the lighter soil offers a more favorable moisture condition than does the heavier soil, even when an equal amount of water penetrates the two soils. When we consider that the run-off on the heavy land is very great and that the rate of penetration is many times less rapid than on the lighter land, the superiority of the latter becomes still more evident.[a]

THE SOIL FERTILITY INDICATED.

Observations in the field as well as pot cultures show that when water is supplied in sufficient quantity short-grass land is most productive, the next in order being wire-grass, then bunch-grass, sandhills mixed, and blow-out land, in the order named; but under ordinary conditions in the field, where the water supply is usually the limiting factor, the order of productivity is by no means that given above, for during dry years bunch-grass land and wire-grass land are much more productive than short-grass land.

Of interest in this connection is the probable duration of the fertility of the soils marked by the different plant associations. Hilgard (Soils, 1906, p. 86) states that in arid and semiarid regions sand is not to be regarded as inferior to other soils in fertility and that there is no reason to suppose that its productiveness is not as lasting as that of the "strong clay soils of the humid regions." The soil, even in the bunch-grass areas, is often dark in color, owing to the presence of a certain amount of humus, and contains a high percentage of the mineral material found in the original rock. In choosing land for farming it would be well to give some attention to the color of the sand, avoiding the lighter colored sand that is commonly found where the blow-out association occurs.

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[a] In a region such as the Great Plains where the rainfall comes during the growing season, the superiority of light over heavy land is probably much greater than in regions of winter rainfall. As a reservoir, the heavy land will hold much more water per cubic foot than light land. Winter rain which enters the soil can be protected by a dust mulch and held in a heavy soil for a long period. J. Widtsoe (The Present Status of Arid Farming in the Great Basin, Official Proceedings of the Dry-Land Congress, 1907, p. 134) states that in Utah "It matters little whether the soil is a sand, a clay, or a loam." But even in this region of winter rainfall the most successful dry farming was originally done on sandy soil. Powell (Report of the Lands of the Arid Region of the United States, with a more detailed account of the lands of Utah, Department of the Interior, 1879, p. 78), in discussing the "Sand Ridge," "south of Ogden and east of Salt Lake," states that "In these localities, and so far as I am aware, in all others where dry land has been successfully farmed, the soil is sandy, and this appears to be an essential condition." In the Great Plains region the summer rainfall makes conditions much more favorable on the lighter land. The condition is very well expressed by Marguerite R. Fink ("Dry Farming," A Homesteader, Official Proceedings Third Dry-Farming Congress, 1909, p. 237): "By experiment we find that clay land will give a luxuriant growth, but it will not ripen, so sandy loam or even a distinctly sandy soil is to be preferred."

AMOUNT OF NATIVE GROWTH PRODUCED.

The geographical distribution of the plant associations and the amount of native growth produced shows that as we pass from the prairie region westward to the more arid region sand becomes relatively a better and better substratum for plants as compared with the heavier soil types. (See pp. 11, 12, and 24.) The bunch-grass association, which produces the largest quantity of dry matter and which in eastern Kansas is able to maintain itself on loam land, is limited largely to the sand in eastern Colorado. The wire-grass association, which succeeds on a loam soil in central Kansas, is found on sandy loam in eastern Colorado. This distribution of the native vegetation in eastern Colorado indicates most clearly that the conditions for growth are more uniformly good on sand than on hard lands. The production of dry matter by the native plant cover varies greatly from year to year. Measurements on August 23, 1909, of the total dry matter, based on croppings of typical square-yard areas and computed in pounds per acre for the sake of convenience in comparison, are as follows: Short-grass land (ordinary cover), 116 pounds; short-grass land (exceptionally close cover), 400 pounds; bunch-grass land (ordinary cover), 840 pounds.[a]

SOIL BLOWING.

It should be noted that in land characterized by the bunch-grass and the sand-hills mixed associations the chief difficulty in producing crops results from the blowing of the soil. The wind by moving the sand not only destroys the young growing crop, but occasionally removes the entire surface layer of the soil. Under natural conditions, where the native sod is undisturbed, this unfavorable condition does not play a part. Consequently, although sand land may produce a much heavier yield of native growth, it does not necessarily follow that it will become proportionately better farming land.

MOISTURE RELATIONS AND CROP PRODUCTION ON HEAVY AND ON LIGHT LANDS.

The physical data given in tables XII to XIV, inclusive, confirm the observations based on the growth of native plants as well as of cultivated crops, that in a region of deficient water supply the lighter soil presents safer conditions for crop production during average years than does the heavier soil. This is largely due to the differences in moisture relations, but must be partly explained as due to the fact that cultivated plants do not grow so large nor use so much water on sand as on the hard land, and they are, on this account, much more likely to mature. The cultivation of hard land can not wholly overcome these differences. The loosening up due to cultivation will increase rather than decrease the water-holding capacity of the upper soil layer. It can, therefore, increase the depth of water penetration and bring about the storing of a greater amount of soil moisture in the lower depths only by reducing run-off, lowering the rate of evaporation, and preventing plant growth. On heavy land crop plants will be stimulated to rapid growth by every rainfall that is sufficient to furnish a good supply of water. But this supply will be limited to the shallow layer of the soil that is occupied by the roots. Drought will do far more damage under these conditions than it would to a crop on lighter land, which has a much deeper layer of moist soil from which to draw its water supply and on which the growth is less luxuriant.

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[a] From the bunch-grass sample all dead stems, which amounted to an additional 1,100 pounds per acre, were removed. Many of these dry stems were produced in former years and were removed in order to reduce the weight to that actually produced during the season when the cropping was made. The short-grass samples contained all of the plant material above the surface of the soil, so that the above comparison is really too favorable to land of this type.

SUMMARY.

(1) The natural vegetation is largely used to indicate the agricultural capabilities of land, but there are many possibilities of error, as this indicator is ordinarily employed.

(2) The object of the present publication is to show how this indicator may be employed accurately for the ready classification of new land.

(3) By indicating clearly the environmental conditions which prevail the native vegetation is of great value, not only in the classification of land, but also as an indicator of the kind of crop and methods of culture that are most likely to succeed under the given conditions.

(4) Differences in the vegetation can be used to indicate changes in one factor of the environment only when all the other factors remain unchanged.

(5) Correlations with soil moisture are usually more easily established than with any other one factor, since it is through this factor that rainfall, evaporation, and the physical character of the soil chiefly affect the plant.

(6) Since plant growth is the ultimate measure of the suitability of the physical environment, the character, growth, and condition of the native vegetation are the best possible indicators of conditions favorable or unfavorable to crop production on land where crops have not yet been produced.

(7) The entire plant cover is a better indicator than the presence or condition of a single species, since in it we have a record which is

as stable as the most stable species and as sensitive as the most exacting plant.

(8) The results described in the present paper are based upon a detailed study of the natural vegetation of Washington and Yuma counties, in eastern Colorado, and upon more general studies made throughout the Great Plains region.

(9) The chief plant associations of eastern Colorado which indicate land of agricultural value are the grama–buffalo-grass association and the wire-grass association (both of which belong to the short-grass formation) and the bunch-grass association and the sand-hills mixed association (both of which belong to the prairie-grass formation).

(10) The chief vegetation types of eastern Colorado which indicate nonagricultural land are the lichen formation, the Gutierrezia-Artemisia association of the short-grass formation, and the blow-out association of the prairie-grass formation.

(11) Of the associations indicating land of agricultural value in eastern Colorado, the grama–buffalo-grass association is most extensive, occupying the greater part of the hard land. The bunch-grass and the sand-hills mixed associations occur only in the sand-hill regions, while the wire-grass association occurs on land of intermediate character.

(12) In eastern Colorado the rainfall records show that the average monthly rainfall is greatest during the period April to August. The increased heat in July and August makes it almost certain that drought will occur in these months. September and the later fall months have normally very little rainfall, and fall-sown grain often fails to germinate unless planted on land in which water from rains earlier in the season has been conserved by summer tillage.

(13) Measurements show that from grama–buffalo-grass land a great amount of water runs off and does not enter the soil.

(14) Soil-moisture determinations in this type of land show that even during periods of more than normal rainfall available soil moisture is limited to a few inches of the surface soil.

(15) On this account the vegetation is composed largely of short grasses which have a great number of roots limited to the surface foot or two of the soil.

(16) Moisture, even in the surface few inches of the soil, is often lacking except during a few weeks in spring and early summer. The short grasses have a comparatively short growing season.

(17) Deep-rooted species are shut out by the lack of soil moisture in the deeper layers of the soil and later-season plants are excluded because available moisture is usually lacking, even in the surface layers, during late summer and autumn.

(18) An open cover of the short grasses indicates conditions less favorable for crop production than a close cover.

(19) The presence of deeper rooted plants mingled with the short-grass vegetation indicates better conditions for crop production than those found where the cover is purely of the short grasses.

(20) The occurrence among the short grasses of plants characteristic of the associations which indicate land without agricultural value suggests a less favorable condition for crop production than where short grasses only are found.

(21) The presence of the wire-grass association indicates that there is a considerable amount of water in the deeper layers of the soil, owing to the lesser run-off and to the fact that the lighter soil permits deeper penetration.

(22) Conditions indicated by the wire-grass association are favorable for both shallow-rooted and deep-rooted plants and for a considerably longer period of growth than those indicated by the grama–buffalo-grass association.

(23) The bunch-grass association indicates a soil that is moist to a considerable depth. Here conditions are more favorable for deep-rooted and late-season plants than in land characterized by either the short-grass or the wire-grass vegetation.

(24) The sand-hills mixed association indicates conditions very similar to those of the bunch-grass association, but rather less favorable, as shown by the smaller amount of plant growth.

(25) The short-grass vegetation represents the final stage in a succession which may begin with the lichen formation and pass through the Gutierrezia-Artemisia association. Or the succession may begin with the blow-out association and pass through the sand-hills mixed and the bunch-grass associations and (by the aid of fires and grazing) through the wire-grass association to a pure short-grass vegetation.

(26) When short-grass land is left without cultivation after breaking it will be revegetated by either the wire-grass or the Gutierrezia-Artemisia association, depending upon the physical conditions.

(27) The vegetation which establishes itself after wire-grass is turned under is that which is naturally characteristic of a lighter soil.

(28) When the native sod of the bunch-grass or the sand-hills mixed associations is broken, a blow-out may result. Usually, however, the original vegetation is soon reestablished.

(29) When the vegetation of any of the plant associations is destroyed by breaking and the land is then abandoned the land will be reoccupied (after a weed stage) by vegetation that is characteristic both of a lighter type of soil and of an earlier stage in the natural

succession. These successions are the result of changes in the physical conditions brought about largely as a result of the destruction and reestablishment of the plant cover itself.

(30) The taller, deeper rooted plants are easily shut out by the shallow-rooted short grasses when the water that falls as rain is not sufficient to penetrate beyond the layer of soil occupied by the roots of the short grasses before it can be absorbed by them.

(31) Where water can readily penetrate below the depth ordinarily reached by the roots of the short grasses the conditions are favorable to the growth of deeper rooted and taller species, which shut out the short grasses by overshading them. This increased penetration of water may be due either to greater rainfall or to lighter soil texture.

(32) When well supplied with water short-grass land is the most productive under cultivation of any in eastern Colorado. During drought, however, crops suffer on this land sooner than on any other type.

(33) During exceptionally dry years bunch-grass land produces the best crops of any in eastern Colorado, but during wet years its production is surpassed by that of all others except the land characterized by the sand-hills mixed association. The soil under both of these types of vegetation is likely to blow badly.

(34) Wire-grass land represents a safe intermediate condition where in years of ample rainfall crop production compares not unfavorably with that on short-grass land and where, even during dry years, a fair crop can often be produced.

(35) One of the chief reasons for the superiority of light land over heavy land in eastern Colorado is that crop growth is rapid on the latter and that the total available supply of soil water lies near the plant roots, the crops, therefore, being in somewhat the same condition as potted plants. These conditions favor a rapid exhaustion of soil moisture and, consequently, bring about sudden drought. On the lighter land water is distributed to greater depths, the plant growth is slower, and plants, by gradually increasing their root area, can resist much longer periods of drought.

(36) Investigations of soil conditions, as well as actual observations of crops in the field and studies of the native plant cover, show that as we pass from the prairie westward to the more arid portion of the Great Plains the lighter soils present relatively more favorable moisture conditions and, therefore, conditions more favorable to plant growth than do the heavier types of land.

CONCLUSIONS.

It is believed that the evidence presented in the present paper justifies the conclusion that the character of the natural plant cover can be used as a reliable indicator of the conditions favorable or unfavorable for crop production, provided the relations between the vegetation and the environment are correctly interpreted.

On the Great Plains a pure short-grass cover indicates a condition of considerable run-off and of limited water penetration, the available moisture usually being confined during the greater part of the season to the first 2 feet of soil. Under cultivation these conditions are modified chiefly by retarding water loss, thus permitting the water to penetrate deeper into the soil. But the penetration is still so slight that the roots of the comparatively shallow-rooted small grains are usually able to occupy the entire depth of soil where water is stored and in time of drought are in much the same condition as potted plants. The rather rank growth on short-grass land made by crops early in the season also greatly increases loss of water by transpiration from the plants and may be instrumental in causing a total failure when dry weather sets in, although with a less vigorous growth the supply might have been fully adequate to the needs of the crop. The presence of a short-grass cover indicates a growing season that is shortened by the limitation of the water supply. Crops which mature early are therefore more likely to succeed on this type of land than crops that require a longer season. Such land is not at all adapted to deep-rooted crops unless the plants are grown far apart and with adequate intertillage. Summer tillage is often necessary to insure the germination of fall grains.

Wire-grass indicates land into which almost all the rainfall penetrates. Because of the lighter texture of the soil the water is distributed to a greater depth, and on this account the native vegetation is partly composed of deep-rooted plants. Under natural conditions evaporation from the soil is here a much less important factor than on short-grass land. The conditions are such that plant roots can not exhaust the soil water as quickly as on short-grass land. The moisture is distributed to a much greater depth, and when drought threatens plants are able to draw on the reserve found in the lower layers of the soil. On this account periods of drought cause much less damage to vegetation on this type of land than on short-grass land. Crop growth on wire-grass land, even during favorable years, is almost as good as on short-grass land, and during average and dry years much better crops are produced on wire-grass than on short-grass land. The native plant cover indicates a considerably longer growing season than on short-grass land, as well as a much more favorable condition for the production of deep-rooted plants.

On bunch-grass land the soil texture is such as to insure the penetration of practically all the water that falls. Cultivation does not seem to retard water loss to any perceptible extent, except by keeping down the growth of weeds. Crop growth is much less luxuriant on this land than on short-grass land when well supplied with moisture. This retardation of growth itself aids in conserving the soil water. When periods of drought occur the roots of the plants can draw upon a large mass of soil which is supplied with available moisture and which serves as a storage reservoir for the crop. The result is that crops on this type of land are comparatively seldom burned up or even wilted by periods of drought. The native plants are such as require a very long season of growth and indicate conditions favorable for deep-rooted as well as late-season crops.

Crop failures occur oftenest on short-grass land; least often on bunch-grass land. The largest yields are obtained during favorable years on short-grass land; the smallest on bunch-grass land. During wet years short-grass land is best; during dry years bunch-grass land is best. Wire-grass land represents a safe intermediate condition, for in years of ample rainfall crop production upon it compares not unfavorably with that on short-grass land, and even during dry years a fair crop can often be produced.

Using the native vegetation as an indicator of the capabilities of crop production, we would class the type of land that is characterized by the wire-grass association year in and year out as the most valuable agricultural land in eastern Colorado. With it, or very close to it, should be classed that type of short-grass land which bears a considerable growth of wire-grass or of Psoralea, for the presence of these plants indicates conditions intermediate between those indicated by the typical wire-grass association and those indicated by the typical grama–buffalo-grass association.

Many of the older settlers in eastern Colorado have moved from short-grass land onto wire-grass land, or even onto bunch-grass land, where they claim there is much less likelihood of crop failure; but the newcomer in the region or the speculator almost invariably chooses the hard or short-grass land because it is darker in color and looks more like the soil he has been accustomed to farm successfully in the East. On this account short-grass land brings the highest price and changes hands oftenest, while wire-grass and bunch-grass lands are not so readily sold and bring much less per acre.

PLATES.

DESCRIPTION OF PLATES.

Plate I. Fig. 1.—A typical view in the grama–buffalo-grass association, Burlington, Colo. A pure short-grass cover, which indicates that available water is limited to the surface layers of the soil and is usually present only during spring and early summer. These conditions are not favorable for long-season or deep-rooted crops. During dry years this land is first to suffer from drought, but during wet years it will produce the largest yields of any type of land in this region. Fig. 2.—A typical view in the wire-grass association, Yuma, Colo. A mat cover of short grasses, together with a number of deep-rooted and taller growing plants, chief among which are wire-grass and Psoralea. This vegetation indicates a longer growing season than the grama–buffalo-grass association, and also that a considerable amount of water penetrates below the root area of the short grasses. Because of the favorable water relations and the facts that the soil does not blow and is very productive when sufficiently supplied with water, wire-grass land is believed to be the best type in this region for general crop production.

Plate II. Fig. 1.—The Gutierrezia-Artemisia association established as a result of breaking or plowing under the short-grass vegetation, Akron, Colo. At the right the comparatively pure grama–buffalo-grass association is undisturbed. At the left the Gutierrezia-Artemisia association has become established on the breaking which was abandoned about eight years before the photograph was taken. Fig. 2.—The wire-grass association established as a result of breaking or plowing under the short-grass vegetation, Yuma, Colo. At the right the pure grama–buffalo-grass association is undisturbed. At the left the wire-grass association has become established on the breaking which was abandoned eight years before the photograph was taken. The soil at a depth of two feet at the left was moist and in fair condition, while at a similar depth at the right it was dry and cracked open.

Plate III. Fig. 1.—Psoralea on short-grass land, Yuma, Colo. A dense short-grass cover amid which appears a rather uniformly scattered growth of the taller bush-like plants of *Psoralea tenuiflora*. This type of vegetation indicates a condition where moisture is available at a considerable depth in the soil, and which is therefore more favorable than pure short-grass land for crop production, especially for deeper rooted crops. This type of vegetation indicates conditions somewhat similar to those indicated by the wire-grass association. Fig. 2.—Wire-grass on short-grass land, Vernon, Colo. A rather close cover of the short grasses amid which are scattered clumps of wire-grass. The wire-grass indicates that at least during spring and early summer there is available water in the deeper layers of the soil, and hence a more favorable condition for crop production. This type of vegetation is closely related to the pure wire-grass association, and indicates conditions similar to those indicated by that association.

Plate IV. Fig. 1.—A typical view in the bunch-grass association, Cope, Colo., a scattered growth of bunch-grass with a variety of other plants occupying the interspaces. This vegetation indicates a soil which is moist to a depth of many feet and a rather long period favorable for plant growth. Large crop yields are never secured on this type of land when under cultivation, but during dry years it will give a better yield than any other type in this region. The chief difficulty with land of this type is that it often blows badly when left unprotected. Fig. 2.—Typical view in the bunch-grass association showing the amount of wild hay produced on land of this type, Yuma, Colo. Hay can not be cut every year from this land, since several years are required for the bunch-grass again to produce a good growth. The value of this hay depends largely on the amount of grama, sand-grass, and big bluestem which it contains.

Plate V. Fig. 1.—A typical view in the sand-hills mixed association, Wray, Colo.; scattered growth of sand sage with clumps of *Calamovilfa longifolia*, *Andropogon hallii*, grama, and a few plants of bunch-grass. A great variety of species occurs in this association. The vegetation indicates a soil which is moist to a depth of many feet and a rather long period of growth. Large crop yields are never obtained on this type of land when under cultivation, but during dry years it will produce almost as well as bunch-grass land. The danger of the soil blowing is even greater than on bunch-grass land. Fig. 2.—The sand-hills mixed association where closely grazed, Wray, Colo. The plants of sand sage here grow luxuriantly. The spaces between these plants are either occupied by the closely grazed plants of the sand-hills mixed association, or, where the grazing has continued for a long period, by an almost pure stand of grama grass. The conditions for crop production are the same as those on land characterized by the unmodified sand-hills mixed association.

Plate VI. Fig. 1.—A blow-out as a result of breaking done twenty years before, Yuma, Colo. This land was plowed and planted to trees which have all blown out except a few at the north side. The trees are soft or silver maple and have made good growth with no care or protection from cattle and horses, which eat off all the foliage within their reach. The vegetation in the foreground is chiefly *Psoralea lanceolata*, that in the background *Redfieldia flexuosa*. Fig. 2.—A typical view in the Gutierrezia-Artemisia association, La Junta, Colo. The plants cover only a small part of the surface of the soil. The principal plants here shown are Gutierrezia and grama grass, but a great many species are important in this association. This type of vegetation indicates a soil which contains a great deal of partly disintegrated rock and one not suited to crop production.

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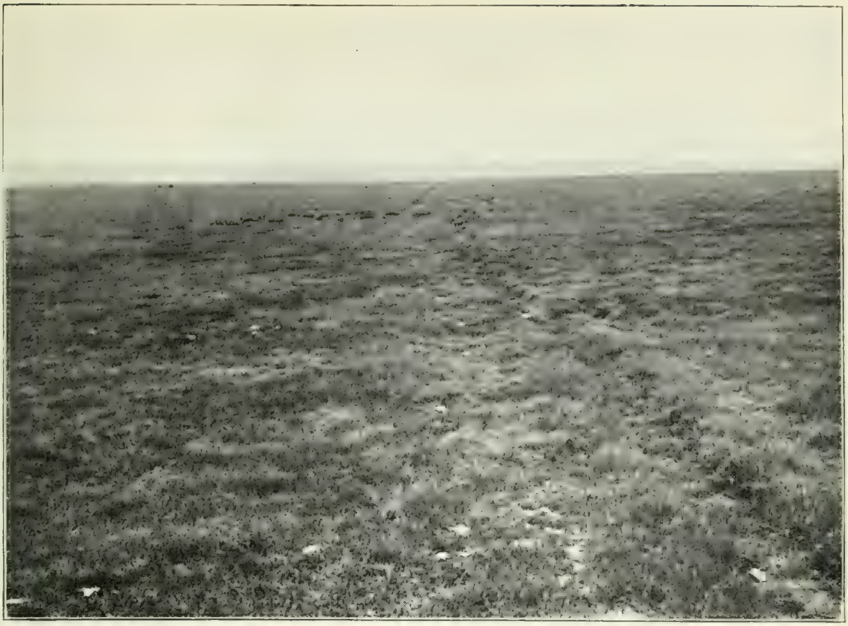

FIG. 1.—TYPICAL VIEW IN THE GRAMA-BUFFALO-GRASS ASSOCIATION, BURLINGTON, COLO.

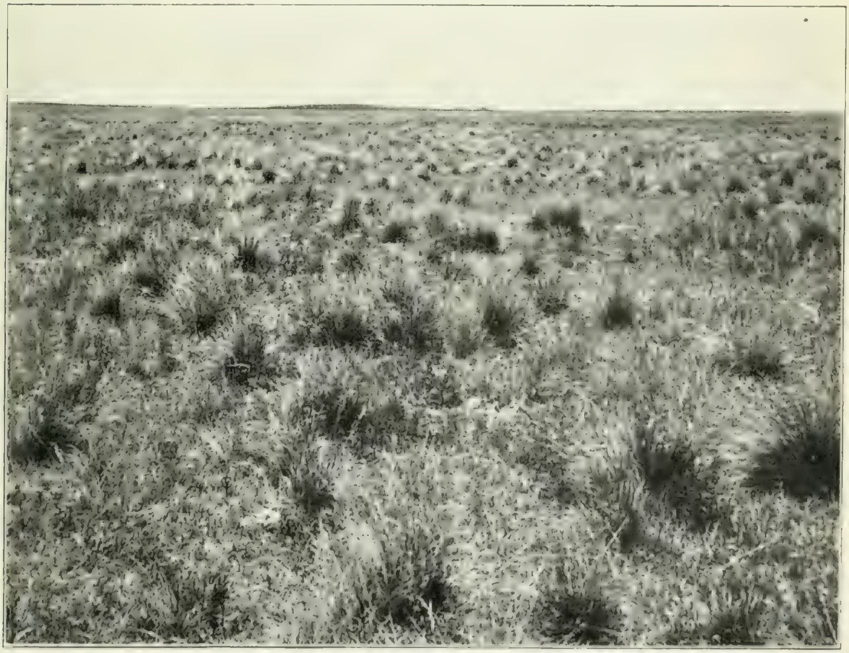

FIG. 2.—TYPICAL VIEW IN THE WIRE-GRASS ASSOCIATION, YUMA, COLO.

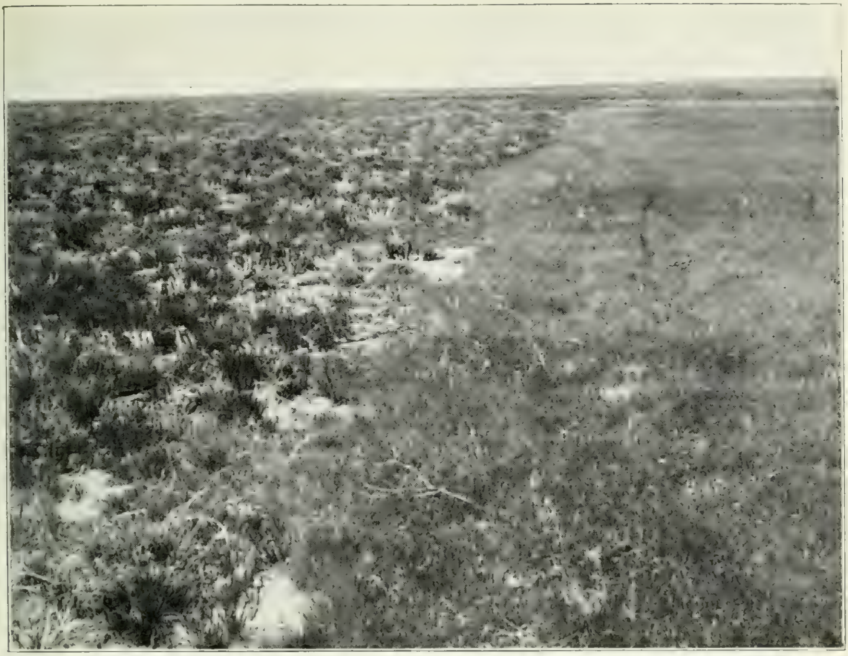

FIG. 1.—THE GUTIERREZIA-ARTEMISIA ASSOCIATION ESTABLISHED AS A RESULT OF BREAKING SHORT-GRASS LAND, AKRON, COLO.

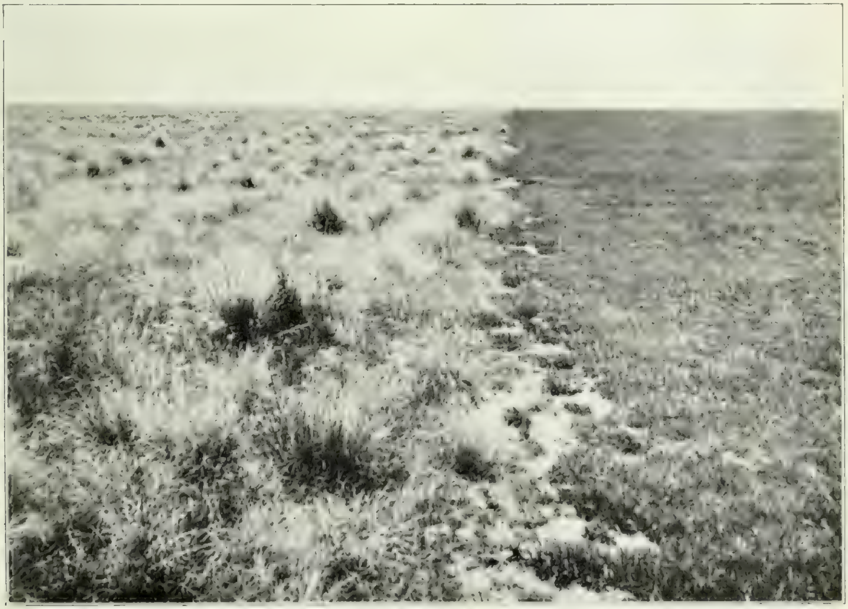

FIG. 2.—THE WIRE-GRASS ASSOCIATION ESTABLISHED AS A RESULT OF BREAKING SHORT-GRASS LAND, YUMA, COLO.

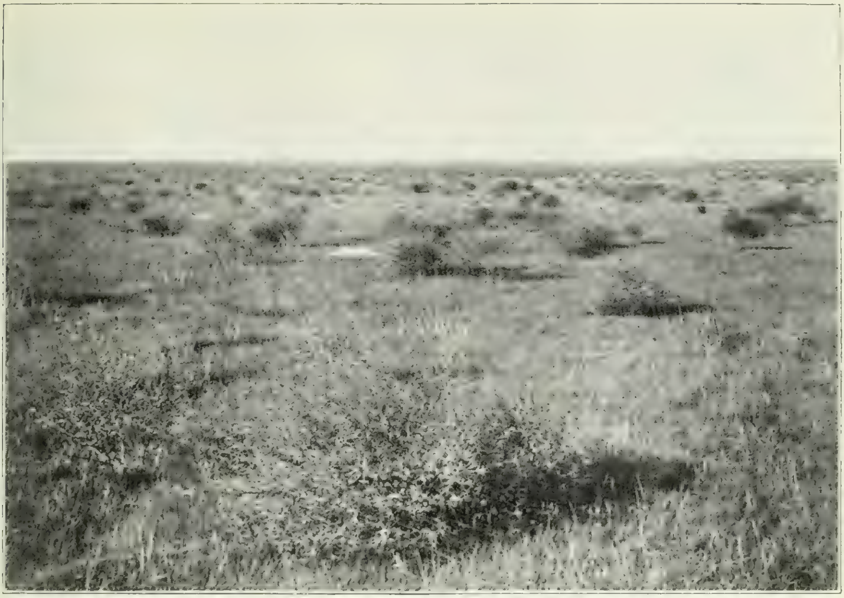

FIG. 1.—PSORALEA ON SHORT-GRASS LAND, YUMA, COLO.

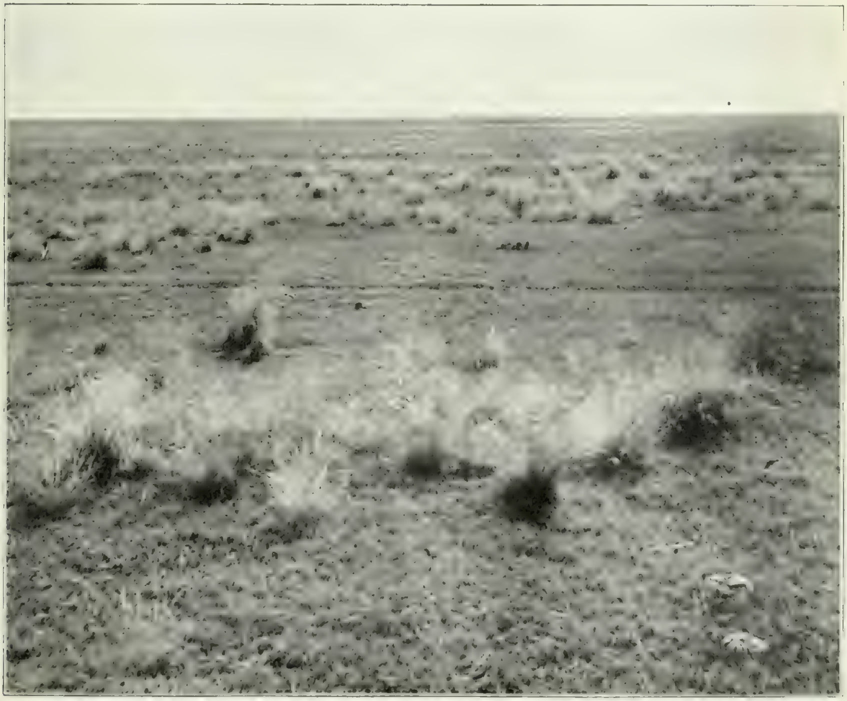

FIG. 2.—WIRE-GRASS ON SHORT-GRASS LAND, VERNON, COLO.

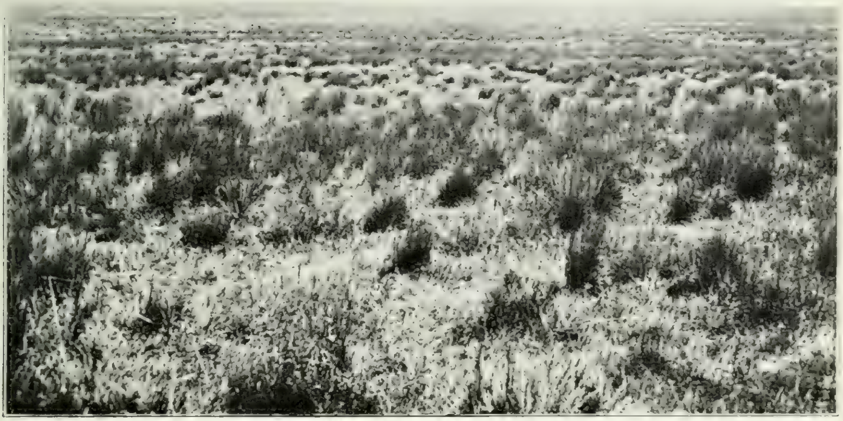

FIG. 1.—TYPICAL VIEW IN THE BUNCH-GRASS ASSOCIATION, COPE, COLO.

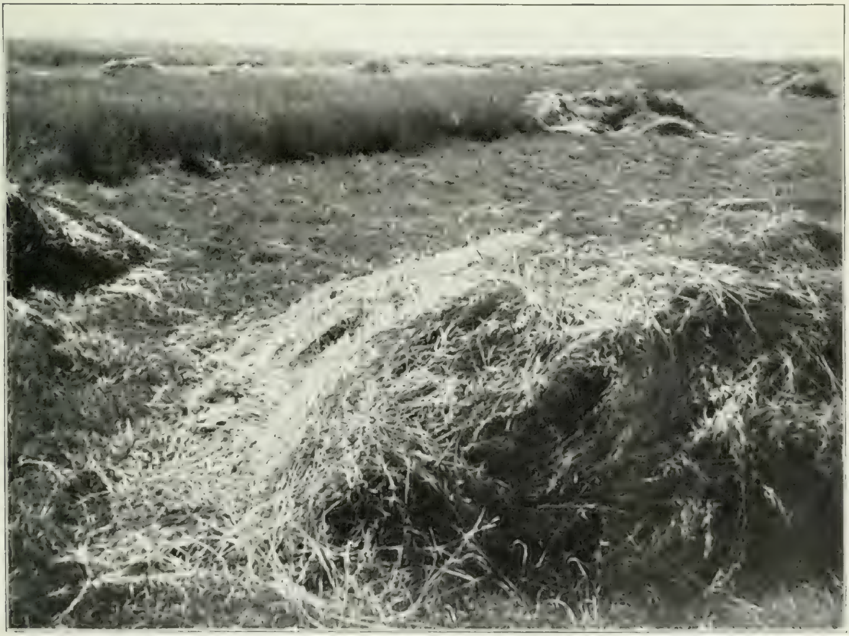

FIG. 2.—THE BUNCH-GRASS ASSOCIATION, SHOWING THE AMOUNT OF HAY PRODUCED, YUMA, COLO.

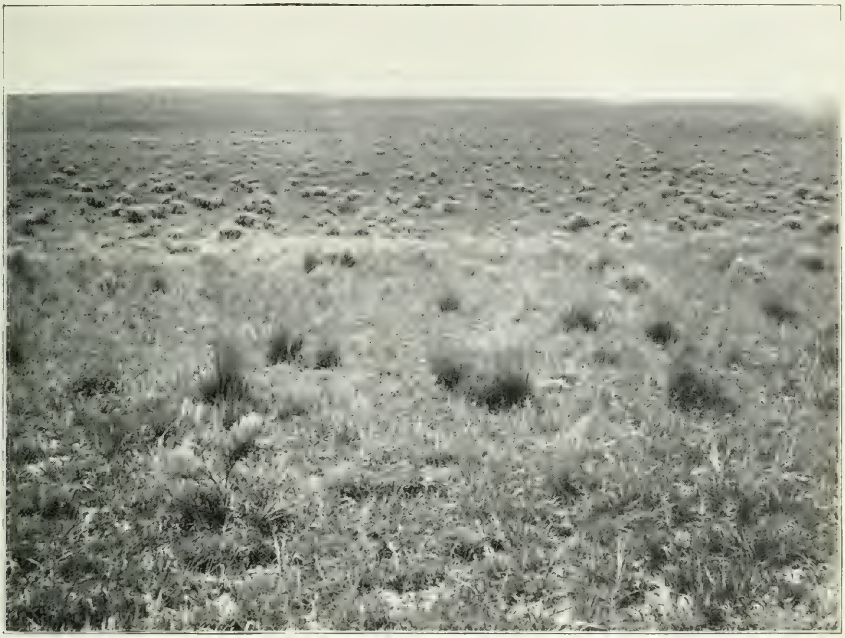

FIG. 1.—TYPICAL VIEW IN THE SAND-HILLS MIXED ASSOCIATION, WRAY, COLO.

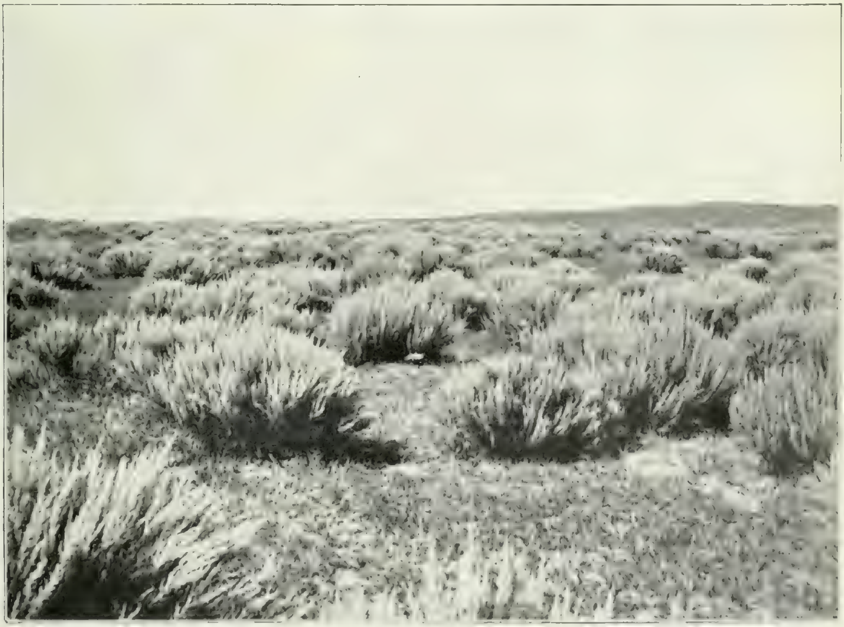

FIG. 2.—THE SAND-HILLS MIXED ASSOCIATION WHERE CLOSELY GRAZED, WRAY, COLO.

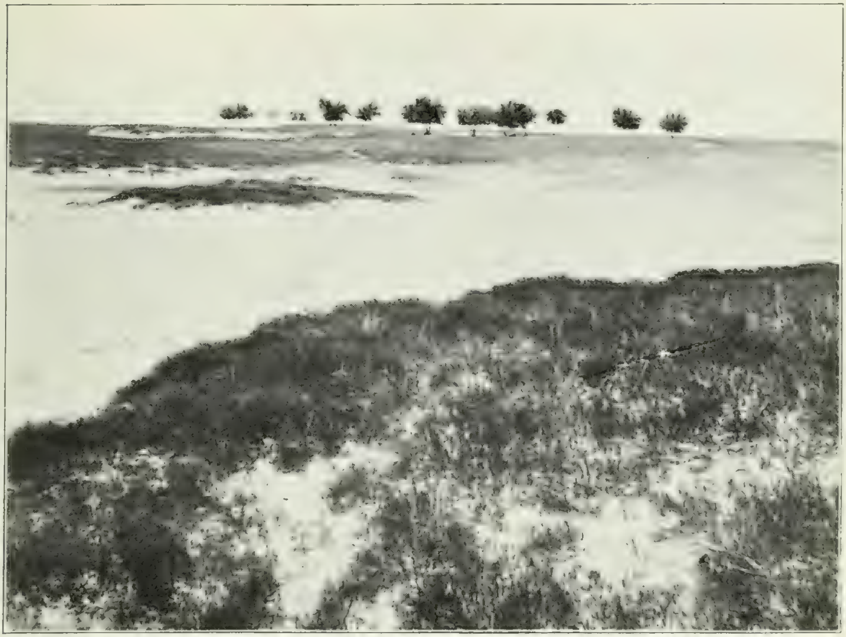

FIG. 1.—BLOW-OUT AS A RESULT OF BREAKING DONE TWENTY YEARS BEFORE, YUMA, COLO.

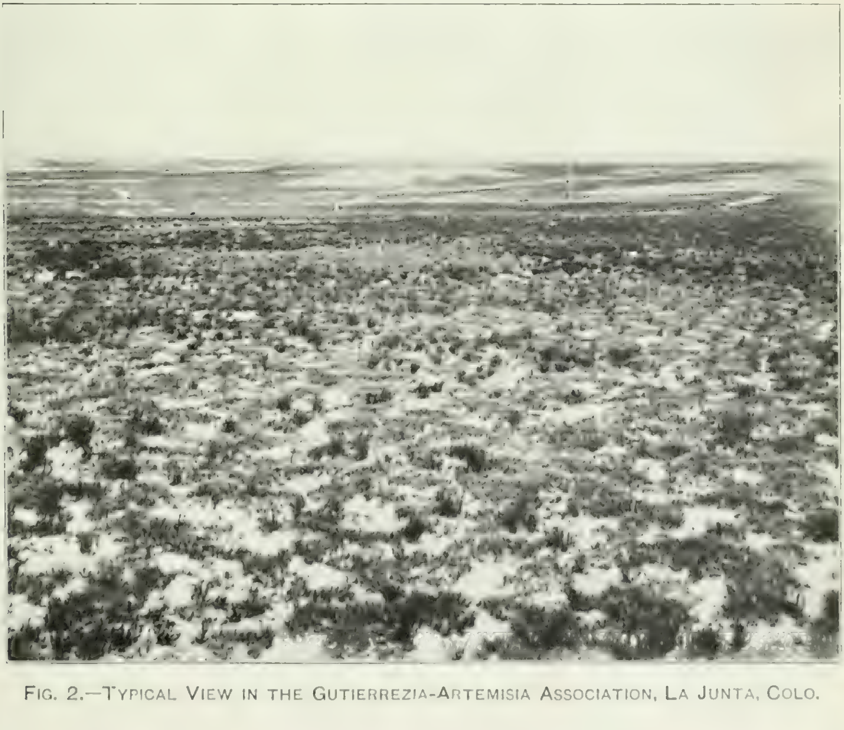

FIG. 2.—TYPICAL VIEW IN THE GUTIERREZIA-ARTEMISIA ASSOCIATION, LA JUNTA, COLO.

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 202.
B. T. GALLOWAY, *Chief of Bureau.*

THE SEEDLING-INARCH AND NURSE-PLANT METHODS OF PROPAGATION.

BY

GEORGE W. OLIVER, PLANT PROPAGATOR.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 20, 1910.

Sir: I have the honor to transmit herewith a manuscript entitled "The Seedling-Inarch and Nurse-Plant Methods of Propagation," by Mr. George W. Oliver, Plant Propagator of this Bureau, and recommend that it be published as Bulletin No. 202 of the Bureau series.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

INTRODUCTORY NOTE.

One of the most important factors in the creation of a plant industry which depends upon a perennial species is the rapid propagation of the plant. The possibility of bringing through the mails from any part of the world a few seeds of some rare plant is of relatively little moment if it is not backed up by adequate methods of quick reproduction from these few seeds through asexual propagation in order to produce large numbers of individuals for experimental trial. One of the greatest drawbacks of horticulture is the time required to test a new variety originated from seed, and any method which shortens the time required to make such tests must appeal to everyone, whether an originator of new varieties or a tester of them, as of the greatest value.

The seedling-inarch method which has been worked out by Mr. Oliver it is believed is destined to prove of the greatest importance not only in connection with the propagation of the tropical and subtropical fruits and ornamental plants with which this bulletin particularly deals (because it has been in his studies with them that he has come to realize its value), but in a very wide range of plant industries in which the early fruiting of a variety is very desirable. This shortening by a year or more of the time required for the fruiting of a new variety is believed to be a matter of such unusual importance as to be worthy of the widest publicity among all interested in the cultivation of plants. The discussion embodied in this bulletin, while it indicates the present stage of our studies of certain tropical-fruit industries, must be considered as having a much more general application than to these few new-fruit possibilities which are as yet little known to the American public.

David Fairchild,
Agricultural Explorer in Charge of
Foreign Seed and Plant Introduction.

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B. P. I.—617.

THE SEEDLING-INARCH AND NURSE-PLANT METHODS OF PROPAGATION.

INTRODUCTION.

While investigating the asexual propagation of some tropical fruit trees and other plants, at the request of Dr. B. T. Galloway, Chief of the Bureau of Plant Industry, it was discovered by the writer that a large number of hard-wooded shrubs and trees are capable of very rapid increase when propagated by processes which may be termed the seedling-inarch and nurse-plant methods.

These methods are inexpensive and, owing to their simplicity, may be used by persons without previous experience in the propagation of plants. By these methods the ever-increasing number of plant breeders will be enabled to save much time in determining the value of hard-wooded plants raised by means of hybridization. They can be used in manipulating seedlings of rare trees and shrubs intended for crossing, so that each plant will bloom in a much shorter time than if left to grow on its own roots. Seedlings of all hard-wooded plants resulting from collections made by travelers in foreign countries may thus be brought to the flowering stage and their value determined quickly.

The most remarkable feature of the new methods lies not only in their simplicity but also in the certainty of the unions which result. The writer has had very few unsuccessful unions and none among those classes of plants where the most suitable stocks are known and in common use. Not only is it possible to inarch a seedling a few weeks old to a large stock, but a moderate-sized seedling stock can be inarched to a shoot of a rare shrub or tree having the same diameter as the stem of the seedling. A satisfactory union may thus be induced where other methods of asexual propagation have invariably failed.

Rose seedlings resulting from crossing varieties have been inarched on manetti stocks when the seedlings were from 3 to 4 weeks old, and they produced maximum-sized flowers long in advance of those on seedling plants growing on their own roots. The rare finger lime, *Citrus australasica*, sometimes seen in a dwarf, sickly condition in greenhouse collections, has borne fruit in two years after inarching on one of its congeners; and within nine months after flowering, hybrid seedlings between this citrus and a cultivated orange were in their turn inarched on 2-year-old lemon seedlings.

Very young seedlings of hundreds of other rare hard-wooded plants may be worked on the same or allied species or genera and their value determined much in advance of the time when they would flower on their own roots or on plants obtained by grafting or budding from the mature shoots of the seedlings.

Hard-wooded seedlings which need to be flowered in the shortest possible space of time, in order to determine their value, are used for inarching as soon as the first leaves attain a fairly firm texture, as, for example, in the case of the mangosteen. But when seedlings are used as stocks for the vegetative propagation of established varieties by uniting the stocks to small branches, then larger seedlings are used, as, for example, in the case of the mango.

The cultivation of the mango on a large scale has been delayed by our hitherto expensive and clumsy methods of propagation. In a recent bulletin issued by the Commissioner of Agriculture for the West Indies[a] the cost of producing large numbers of the finer varieties of cacao plants by inarching the small branches of these varieties to seedlings grown in bamboo pots is given at 6 cents each. In places where the mother mango trees have already been grown and are available for such use the owner will find the cost per inarched plant by the method here given to be reasonably small because the mango is as easy to inarch as the cacao.

Since the introduction by the Bureau of Plant Industry of more than a hundred varieties of the mango from India and other parts of the world, the cultivation of this much-esteemed fruit in the semitropical parts of the United States and elsewhere is gradually assuming important proportions. The propagation of young trees of those varieties which have been tested must necessarily be accomplished by asexual methods, as the finer Indian varieties do not come true from seeds.

The methods of propagation up to the present time have all been more or less faulty and cumbersome. The budding of seedlings in nursery rows requires the services of a trained propagator who knows what to do and how and when to do it. The average cultivator can hardly hope to acquire the skill necessary for the operation; moreover, there is always danger of loss from transplanting budded seedlings. Propagation by the older method of inarching on plants growing in 5 and 6 inch pots, sometimes for more than a year, is an expensive method, necessitating the erection of strong staging around the parent trees for the accommodation of the plants in pots; moreover, the roots of the seedlings become curled in the pots and make it difficult to develop a good root system for the future tree. The method here described has the advantage of being by far the easiest to use. Each grower may be his own propagator. With a helper to prepare the seedlings he can easily inarch several hundred plants in a day.

---

[a] Jones, J. The Grafting of Cacao. Dominica, 1909.

Many plants belonging to various genera have the reputation of being difficult to propagate asexually, but this is due mainly to lack of knowledge in regard to methods. The greater portion of those dicotyledonous plants considered to be difficult or impossible to propagate have this reputation because the methods successfully used on other plants have been applied and found ineffective. There are doubtless easy methods of asexual propagation for all hard-wooded dicotyledonous plants and even for some of the refractory monocotyledons.

The method described in the following pages appears to be the only one which has been successfully applied to the rarest and most prized of tropical fruit trees, the mangosteen. This is a fruit of high quality, and its cultivation on a large scale has been delayed principally by the difficulties encountered in its asexual propagation. Material for the work of propagation is somewhat difficult to obtain, but where an abundant supply is available seedling plants may be inarched with as little expense as with the young branches of the mango.

The method has also been very successful with rare varieties of the Chinese litchi, branches of these having been united with very small seedlings of common forms of the same species.

INARCHING ROSE SEEDLINGS.

Seedlings of some of the rose groups resulting from crossing distinct varieties or otherwise take more than one season to produce flowers of maximum size to enable the breeder to judge of their merits. They take much longer to develop when budded on manetti or other stocks, because in that case a considerable time has to elapse before the growth of the seedling is strong enough to give buds and wood fit for propagation by budding or by grafting. Rose seedlings 3 to 4 weeks old, or after the first few character leaves are developed, lend themselves very readily to the seedling-inarch method of propagation. Tea and hybrid-tea seedling roses will give flowers of maximum size very quickly after the tiny seedlings are inarched to strong-growing manetti or other stocks, thereby saving much time in preliminary tests.

The operation of inarching is simplified if each seedling is pricked off into a 2-inch pot shortly after the cotyledons are developed. The seedling should be placed as near the rim as possible (fig. 1). In two or three weeks the seedling makes sufficient growth to be removed from the pot, when a little fresh soil is held in place around the root by a piece of cloth about 5 inches square (fig. 2). The ball containing the roots of the seedling is secured to the stock, the stem of the seedling being placed close to it, so that the inarch may be easily accomplished

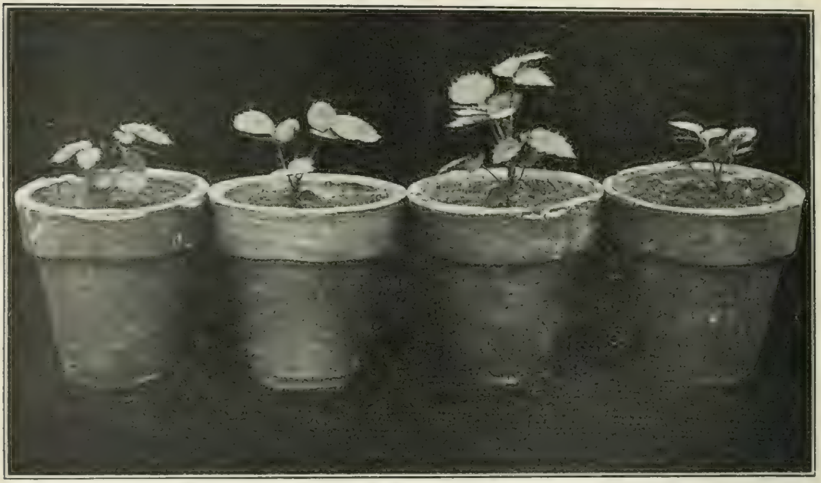

FIG. 1.—Rose seedlings, a cross between two varieties, four weeks after germination. Each seedling is grown close to the rim of a 2-inch pot so as to facilitate an easy approach to the stock plants when inarching.

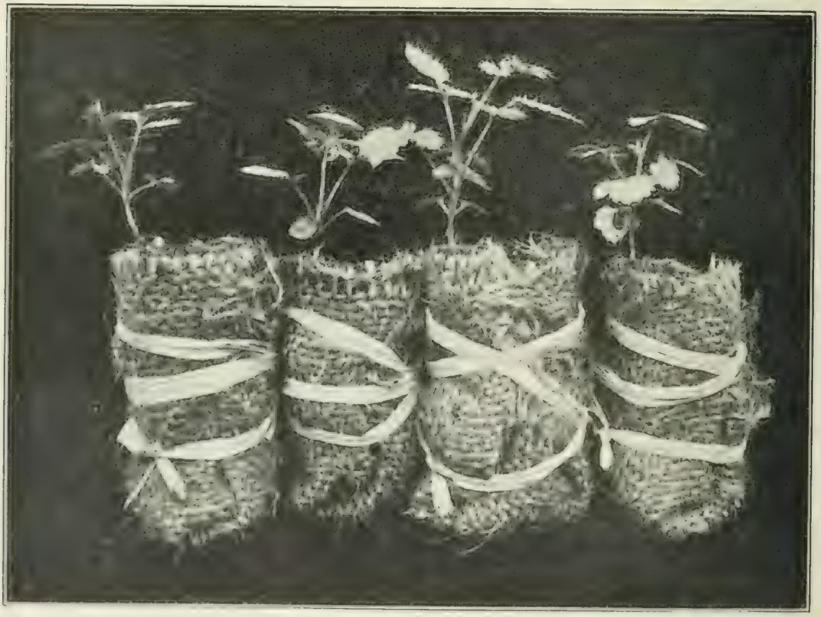

FIG. 2.—The rose seedlings shown in figure 1 four weeks after germination, prepared for inarching.

(fig. 3). The union is a rapid one and becomes perfect some time before the cotyledons decay.

It is well known that many seedling roses on their own roots produce flowers before the cotyledons decay, but the flowers are necessarily small and have little to indicate their eventual value. The seedling-inarch system shortens very considerably the period between germination and the production of flowers of maximum size—a material aid to the breeder in determining the value of the seedling within a few months after germination (fig. 4).

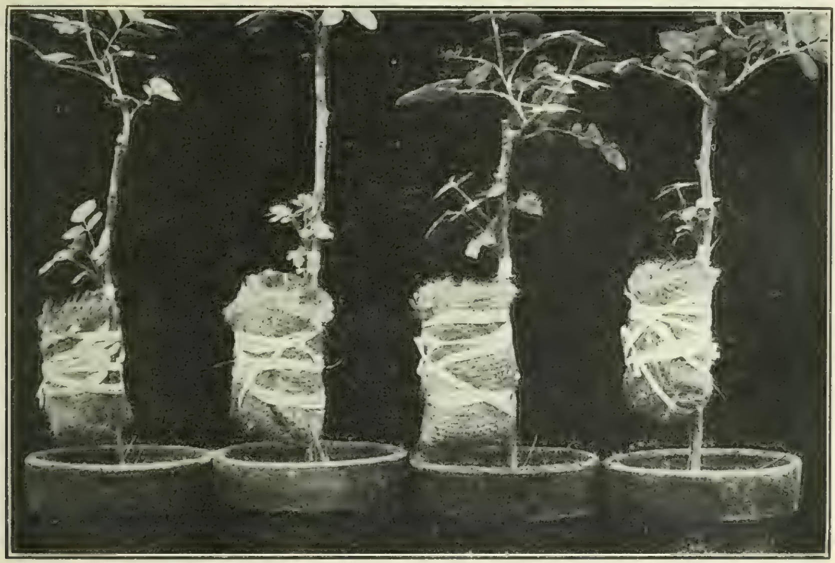

Fig. 3.—Rose seedlings, four weeks after germination, inarched to stocks of the manetti rose. During the process of uniting, the seedlings are kept in a moist and growing condition by the soil held around the union by burlap. A good union is effected in three to four weeks.

PROPAGATION OF THE FINGER LIME.

To illustrate the possibilities of the seedling-inarch method, figures 5 and 6 show a seedling of the rare *Citrus australasica* five weeks after germination inarched on a 2-year-old lemon seedling. A branch of fruit from this inarched seedling is shown in Plate I, figure 1, as it appeared two years later. The two flowers which produced these fruits were fertilized with pollen from the flowers of a small orange tree. Thirteen seedlings resulted, and one of the seedlings from this cross, two years and eight months after the seed of the female parent tree was sown, is shown in Plate I, figure 2. All these seedlings in their turn, three weeks after germination, were successfully worked on seedling citrus stocks 1 to 3 years old, and in two more years these tiny inarched-seedling crosses are expected to bloom and produce fruit.

THE SEEDLING-INARCH METHOD APPLICABLE TO NEW PLANT INTRODUCTIONS.

Seedlings raised from seeds of new and rare trees, shrubs, and vines may be induced to grow very quickly if used as scions when a few weeks old by inarching to strong-growing plants of other species of the same genus or in some cases on species of other genera of the same family. This has been done recently with such plants as chestnuts, walnuts, hawthorns, oaks, and many others. It is not necessarily done for the purpose of hastening the flowering or the fruiting of new plants, but to give quickly an abundance of material for propagation by budding or grafting when the new material is assumed to be valuable.

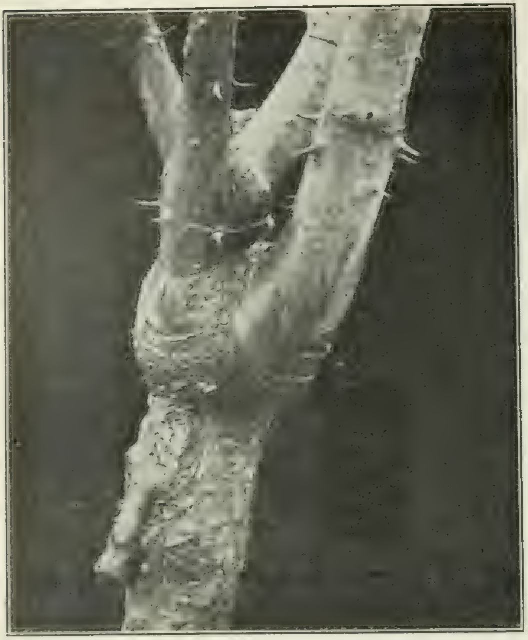

FIG. 4.—Inarched rose seedling, showing the growth made in two months after inarching. (One and one-fourth times natural size.)

If a hard-wood seedling of hybrid origin is tied to a large stock and they fail to unite, there is little or no danger of losing the seedling, provided its roots are kept damp during the period of making the attempt. If the inarch is not successful, the seedling can be repotted and grown in the usual way.

PROPAGATING THE MANGO.

SELECTING AND PREPARING THE SEEDS.

Seeds of the mango vary in size according to the variety, ranging from a little over an inch to several inches in length and from 1 to 2 inches or more in breadth. For producing stock plants good judgment should be used in procuring seeds from the fruits of healthy, vigorous trees, either cultivated or otherwise. The fruits should be gathered as soon as they are ripe on the tree, rejecting fallen and decaying fruits of either healthy or sickly trees. The seeds should be removed and cleared of the fruit pulp shortly after the fruit is ripe, and washed to remove as much as possible of the pulp adhering to the fiber; otherwise rotting is likely to occur. Before sowing, the seeds should be allowed to become fairly dry on the surface.

SOIL FOR SPROUTING THE SEEDS.

The best medium in which to germinate mango seeds is undoubtedly slightly decomposed coconut fiber, which after being used can be dried out and used again. The next best medium is good hammock soil, but any other material containing a large proportion of decomposed vegetable matter may be substituted.

The seed bed should be prepared in a sheltered place not too much exposed to the sun's rays and protected from heavy rains with hotbed sash, if necessary. Provision should be made whereby the water shed from the sash will not drain into the bed. Wooden flats about 4 inches deep and of convenient length and width for easy handling may be used in sprouting small lots of seeds.

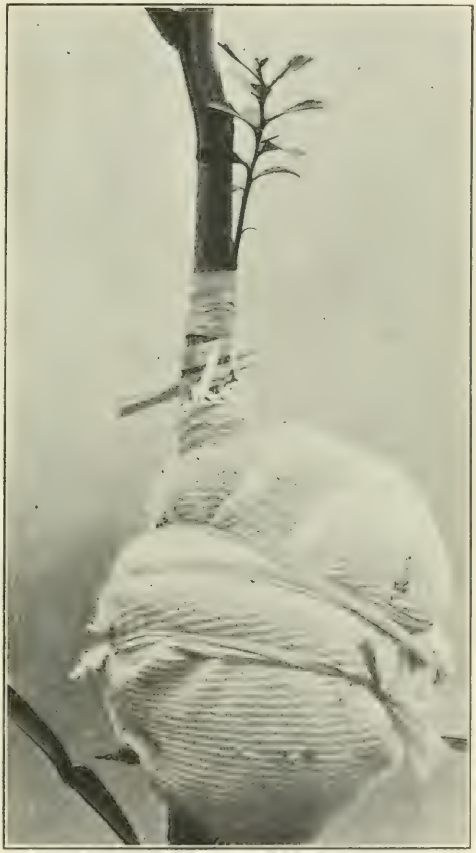

Fig. 5.—Seedling of the finger lime (*Citrus australasica*) five weeks old, inarched to a 2-year-old lemon stock. The cloth is used to keep the soil in place around the roots of the seedling so as to sustain it during the process of uniting with the stock.

RAISING SEEDLING STOCKS.

The seeds may be planted 2 or 3 inches apart and covered with about 1 inch of soil; they germinate freely within a few weeks if the seed bed is kept moist. A seed from an uncultivated tree in Florida usually produces several sprouts (Pl. II), but not all of them become strong plants. Seeds of some varieties procured from India and also from the Philippine Islands usually produce a single sprout. These plants make ideal stocks. When the first flush of leaves is fairly well matured the strongest plants may be separated from those that are weak and potted singly, each being given a 4-inch pot, or if the pots are not available they may be placed in wooden receptacles not over 4 inches square and of the same depth.

When a seedling intended for use in inarching is potted or boxed, it should not be placed in the center of the receptacle. It will be found convenient and will cause less strain both on the stem of the seedling and on that of the shoot while the union is taking place if the stem of the seedling is near the edge of the pot or box (fig. 7). The seedling so placed when subsequently prepared for inarching may be united at a point an inch or so above the soil. The plants should be potted rather firmly in hammock soil of a nature similar to that used for germinating the seeds, with a small quantity of decomposed stable manure added. A space should be left between the top of the soil and the top of the pot, say three-fourths of an inch, so that for the time being a single watering will moisten the soil thoroughly.

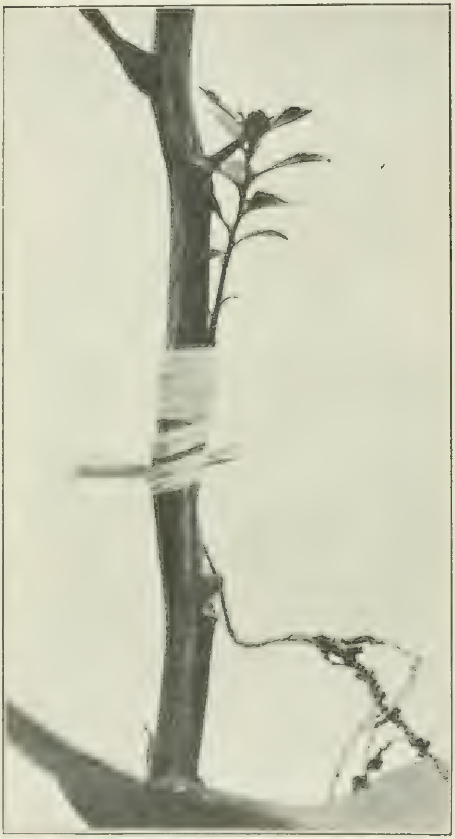

FIG. 6.—The same plant of the finger lime shown in figure 5 thirty days later. At this stage the top of the stock and the root of the seedling are ready to be removed.

PREPARATION OF SEEDLINGS PREVIOUS TO INARCHING.

In a few weeks some of the strongest of the seedlings will have made sufficient diameter of stem to be used as stocks for inarching. When the stem of the seedling reaches a diameter of a quarter of an inch and is fairly firm in texture (fig. 8), preparations for inarching may be commenced. The seedling is not inarched while in the pot, because even a 4-inch pot adds considerably to the weight (enough to make it impossible to tie it to the inarched branch); besides, its contents would dry out too quickly. Thick sacking cloth cut into pieces about 10 inches square is substituted for the pot. The seedling when removed from the pot is divested of that part of the soil, usually near the top, in which no roots have formed. The remaining part of the ball is then given a protective covering of old coconut fiber or hammock soil, or if this is not convenient, chopped sphagnum moss, sand, and decomposed stable manure may be used. Part of the coconut fiber or other material is placed on the outstretched piece of sacking upon which the ball of the plant is then laid, and as the sacking is being brought up and around the ball additional soil is placed about the roots. Enough of this soil should be used to hold the moisture that is necessary while the seedling and branch are uniting. The sacking is then tied firmly with a piece of strong string and the plant is ready for working (fig. 8). This operation may be performed in about the time required to pot a seedling. Several hundred seedlings may be thus prepared at one time, and if the tree is not more than 4 or 5 feet in height every shoot may be inarched. (See fig. 9.)

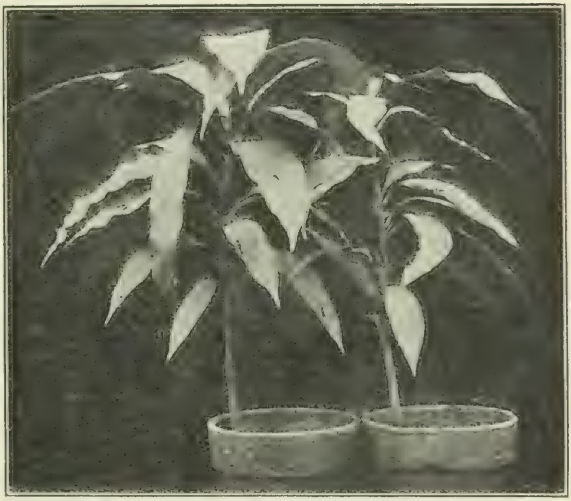
FIG. 7.—Seedling mangos four months old in 4-inch pots. The stems of the stocks are about one-fourth inch in diameter. When potting, the seedlings are placed close to the rims of the pots to prevent strain on the stock and scion when inarching.

THE CONVENIENT PLACING OF MOTHER PLANTS FOR INARCHING.

Most of the work of inarching on seedlings in large pots has hitherto been done in the field. Large and unwieldy platforms have been built around trees on which to place the potted seedlings convenient for inarching with small branches.

By the new method of inarching, this trouble and expense are unnecessary. The process of inarching and caring for the seedlings during the period of uniting will require much less work than by the older methods. Plants of tested and approved varieties intended for use in propagation can be kept from growing more than 5 or 6 feet in height. There is then no necessity for wooden staging, as the prepared seedlings weigh only about 1 pound each. A seedling in a 5-inch pot weighing nearly 4 pounds needs benching to support it, but the small seedlings tied in cloth can be supported by individual stakes or by a piece of string secured to a stout branch (fig. 9). The use of large or even moderate-sized mango trees growing in the field with several feet of stem above ground for propagating purposes is inadvisable by the method herein described, because of the inconvenience entailed both in the operation of tying on the seedlings and in supplying them with water and shade during the time of uniting.

It would be a great saving of time and work if the trees to be propagated were planted moderately close together inside a lath structure, such as is used in many parts of Florida. This would not only give protection from the sun, but with the different desirable varieties contained in an inclosure of this nature, the work of caring for them would be reduced to a minimum. The trees could be kept dwarf, the seedlings put in place without inconvenience, and a large number of

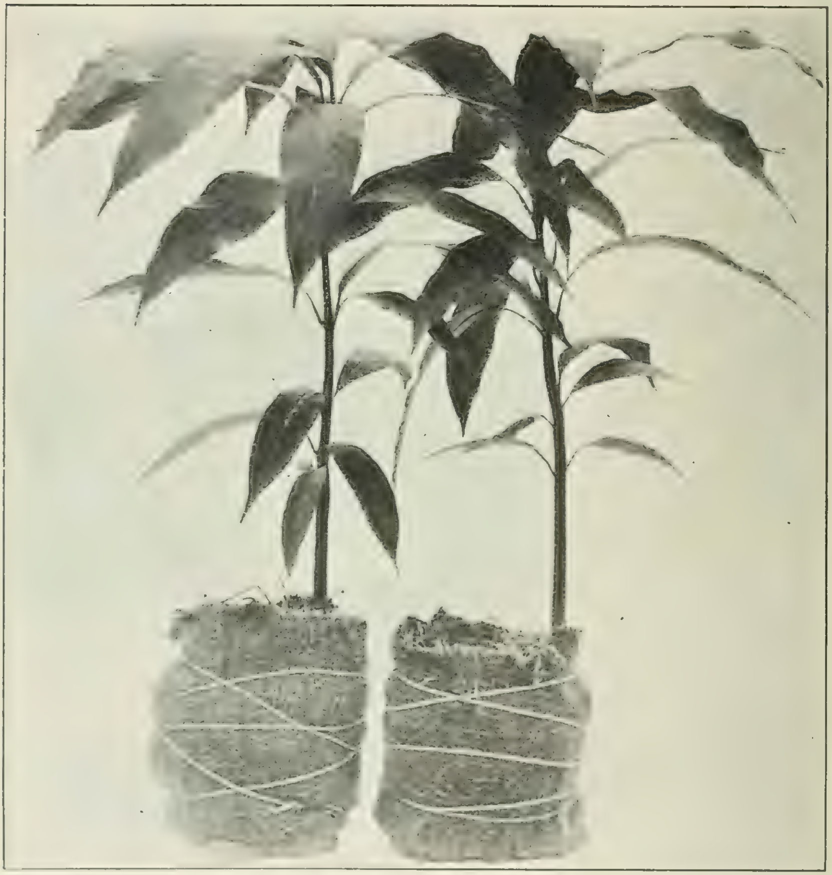

FIG. 8.—Seedling mango stocks prepared for inarching. The topsoil, in which there are no roots, is removed, and additional soil or coconut fiber is placed around the ball and held in place with a piece of sacking. The seedlings are then ready to be inarched. Each plant when thus prepared weighs about 1 pound.

seedlings attached to branches could be watered conveniently. Every small, ripened branch could be used for inarching, and in the case of tested and approved varieties the inarched seedlings could be planted out and kept as stock plants, to be used for inarching later on. It is entirely possible to grow a very large number of seedling-inarched plants within a few years, beginning with only a single plant in a 5-inch pot.

In Florida, mango trees of tested varieties have been grown into symmetrical specimens with many branches close to the ground, as seen in Plate V, figure 1. When a tree of an approved variety has this habit, it is a simple matter to propagate enough young trees from it within two months to plant at least 10 acres of ground, and with a very small expenditure of money. Certainly with the material already at hand the cost per plant ready for setting out will be trifling.

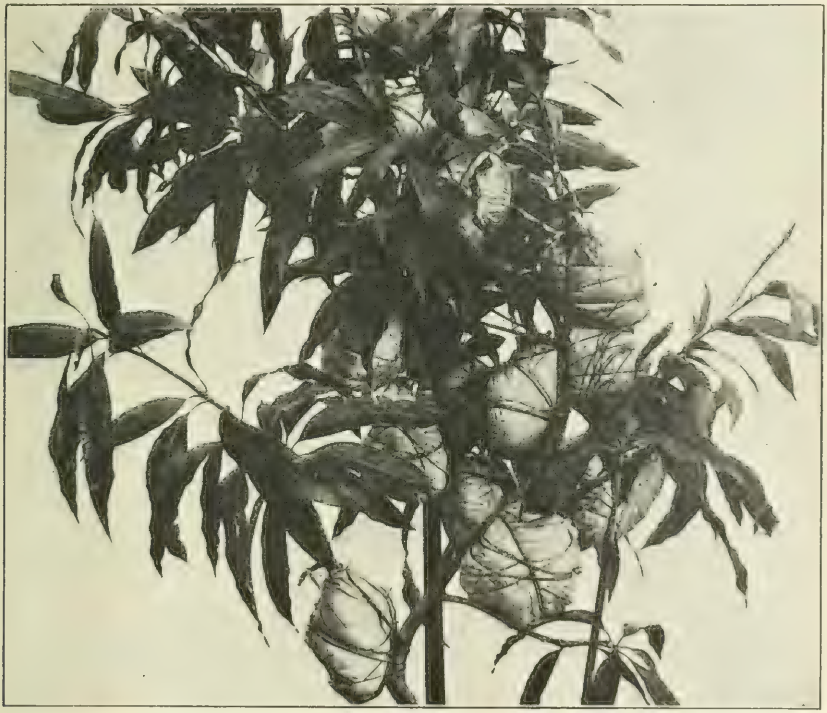

FIG. 9.—Branch of mango with 11 shoots inarched to seedlings. This branch is supported by a stout stake, which takes the place of the elaborate benching formerly used for the support of plants in large pots.

MAKING THE INARCH.

First select the branchlet to be inarched, taking care that the diameter of the stem is not greater than that of the seedling stock. It should be fairly well ripened and have several healthy leaves (Pl. III, fig. 1). Make a cut in the stem, beginning at a point 2 to 3 inches from the terminal bud (Pl. III, fig. 1, *A*); in taking a slice from the stem cut into the wood not more than one-third of its diameter. The slice removed may be about 2 inches in length; any leaves which hinder this operation should first be cut off. Make a cut of similar length and depth near the base of the stem of the seedling (Pl. III, fig. 1, *B*). Bring the stock and scion neatly together, the bark meeting on both sides if possible, and tie firmly with a piece of soft string or strand of raffia (Pl. III, fig. 2). After this is done it only remains to secure the ball of the seedling to the lower part of the branch; or if the inarched branch is a short one the ball may be tied to the older wood. It will often happen that the seedling will need no further support; but when necessary a cane stake for further tying may be utilized (fig. 9), or a strong cord may be fastened to a stout stake driven into the soil in a convenient position and the inarched seedlings attached to it. Many little devices of like nature will suggest themselves to suit the peculiarities of each mother tree on which it is desired to make inarches.

WATERING SEEDLING STOCKS WHILE UNITING.

The process of uniting the seedlings to small branches of the mango trees will in no case be completed in less than four weeks; if the weather is cool it sometimes takes six weeks to effect a satisfactory union. It is very essential that the roots of the seedling be kept moist while the union is taking place. Under glass this is accomplished satisfactorily by the usual daily syringings, but out of doors, on large specimens, careful watching is absolutely necessary to prevent the seedling stocks from drying out at the roots. If the mother plants are growing within a lath structure, a syringing once or twice each day according to the weather will be all that is required. The seedlings should be often examined to ascertain their condition and supply their wants in this respect. While the stems are uniting with the branches the roots of the seedlings, if surrounded with such material as coconut fiber, will not dry out any more quickly than they would under the conditions accompanying the old method of inarching branches to large seedlings in pots.

The result of this method is to effect a perfect union. Staging for the support of large, potted seedlings is not necessary; there is absolutely no waste of material; and a much greater number of inarched plants can be grown in a given time, and much more cheaply, than by any of the older methods.

TREATMENT OF THE INARCHES BEFORE SEVERING FROM THE PARENT TREE.

During the spring and summer months the unions will be in a satisfactory condition in from four to six weeks after the operation of inarching is performed. But the scions must not be severed from the parent tree all at once. Unless the separation is performed gradually, the check is too severe and may result in their collapse. By examining a few of the inarches about four weeks after they have been worked it will be readily ascertained if a union has taken place or if there is a likelihood of its being effected. When that stage is reached—that is, when the branch and the seedling seem fairly well united—the top part of the stock at the point immediately above the union and on the side opposite to it may be cut halfway through. A few days later the small branch united to the seedling at a point immediately below the union should be cut to one-third of its diameter; another cut may be given a few days later and the branch, together with the top of the seedling, may be entirely severed when a safe union is effected (Pl. IV, fig. 1). It should be understood that the time required for a satisfactory union depends upon several factors, such as the weather, condition of the scion, root condition of the stock, etc., but, as thousands of successfully inarched plants have shown, there is no danger of failure if the conditions be correct.

During the past three years many persons interested in the mango from southern Florida and from places abroad have visited the propagating houses of the Bureau of Plant Industry. Simple instructions to each visitor have enabled him to attach a seedling to a mango branch with not a single resulting failure.

TREATMENT OF INARCHED PLANTS.

As soon as the inarched plants are severed from the parent tree they may be placed in a shaded frame for a few days before potting, to prevent wilting of the leaves. The atmosphere should be kept moderately moist, with the temperature not too high. The plants may then be prepared for potting by removing the string and burlap. Five-inch pots or shingle boxes 5 inches deep will be found large enough for most of the plants (Pl. IV, fig. 2). The soil will necessarily be that obtainable in the vicinity of the operations. Where loam is not available, hammock soil can be substituted, improved by adding finely chopped, old stable manure and using 1 part of this to 3 of the soil, ramming the mixture firmly around the original ball. Water is applied sparingly at first, but in sufficient quantity to keep the air moist around the plants, so as to encourage root growth. A deep frame facing north will supply the conditions necessary in this respect. The water is best supplied to the plants by a watering can with sprinkling attachment.

As soon as the plants are established in their receptacles they should be gradually exposed to air and sunshine. Plants grown by this method (Pl. V, fig. 2), being worked immediately above the soil, can be safely sent long distances by mail. The Bureau of Plant Industry has successfully shipped inarched plants by mail to the Hawaiian Islands, and many hundreds have also been successfully sent by mail to experimenters in southern Florida.

TESTING THE NUMEROUS VARIETIES OF THE INDIAN AND OTHER MANGOS IN FLORIDA.

Although nearly a hundred varieties of the mango are now growing in Florida and elsewhere, principally as a result of the seedling-inarch method, only about a dozen have fruited sufficiently to determine the quality of the fruit and its adaptability for the market. It is to be feared that many of these untested varieties are being increased irrespective of their merits. This is a mistaken policy and in many cases it may prove an expensive one. The aim of cultivators should rather be, in fruiting a variety the fruit of which is

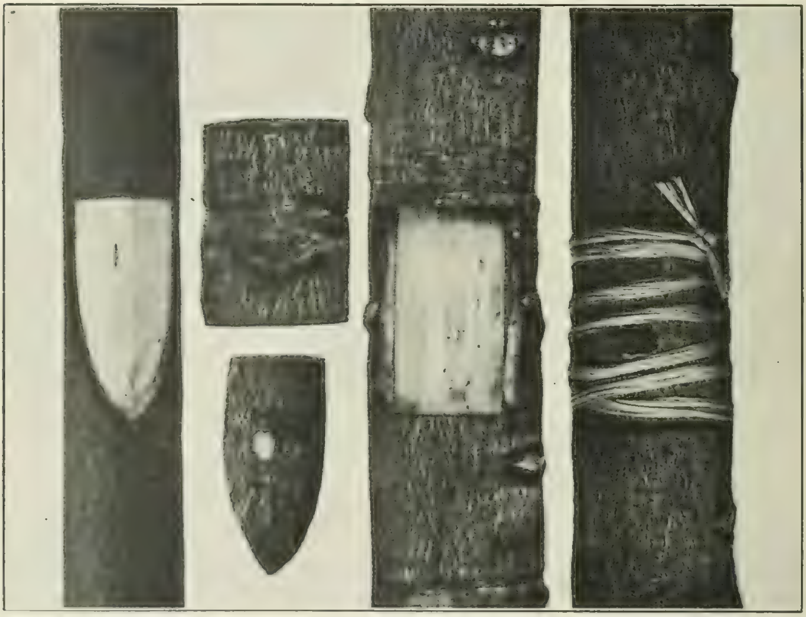

FIG. 10.—Illustration of very old methods of budding used on the mango in Florida and elsewhere. These methods involve a great waste of material. They are illustrated and described in Robert Sharrock's "History of the Propagation and Improvement of Vegetables," 1672.

unknown in Florida, to determine its worth before propagating it extensively. This may be done by using small seedling-inarched plants, after they have become established in 5-inch pots, for inarching on the old wood of stout branches.

After removing the plant from the pot, inclose the ball with soil kept in place with a piece of sacking and strong cord. Inarch the top of the plant to the thick part of a branch of a fruiting tree. Half a dozen or more distinct varieties may be placed on a single tree and carefully labeled. When the unions are secured, gradually remove the branch of the tree above the union, also the original inarched plant below the union, and coat the cut surfaces, especially that of the stock, with grafting wax so as to prevent decay. If the soil of the plants to be inarched is kept moist during the process of uniting the chances of failure are remote. The young inarched shoots will make rapid headway and will fruit much more quickly than young plants set out for testing. Two of the very old methods of budding, which are used on the mango in Florida and in other countries, are shown in figure 10.

PROPAGATING THE MANGOSTEEN.

GENERAL STATEMENT.

The mangosteen is one of the most remarkable of trees in that until lately it has defied attempts at asexual propagation. It has also the reputation of being the most difficult of all trees to grow. Most people who have sampled it pronounce it the most luscious of all tropical fruits (figs. 11 and 12).

The contention that the mangosteen is difficult to grow is abundantly proved in countries where it is cultivated and the high praise bestowed on the fruit is also well authenticated. The mangosteen is a native of the Malay Peninsula and Archipelago. It is cultivated in a small way in Ceylon, southern India, and Cochin China, and there are a few trees in the warmer islands of the West Indies, but nowhere is it cultivated to the same extent as other tropical fruit trees. It is doubtful whether more than a dozen fruiting trees can be found in the Western Hemisphere. Its requirements have probably not been understood here or elsewhere, as there is abundant evidence that it has time and again been planted in very unfriendly soils and under adverse climatic conditions. There is now little doubt that as a result of the successful experiments in its propagation in the greenhouses of the Department of Agriculture it will be possible to obtain healthy growth, especially where the mangosteen seedlings have been inarched on other species of Garcinia and also on other genera of the order to which the mangosteen belongs.

In the propagation of the mangosteen the method so successfully used with the mango, already described, is reversed. With the mango the seedling is used as the stock, but with the mangosteen the seedling is used as the scion. This would not be necessary if the shoots of the mangosteen tree were as easy to inarch as are the shoots of the mango. Two instances are recorded of attempts to propagate the mangosteen by inarching on other species of Garcinia.[a] In each instance the attempt at inarching seems to have been carried no further than to determine that a partial union took place between the stock and the scion. By a method similar to that used by Woodrow and Harris the writer was at first also unsuccessful.

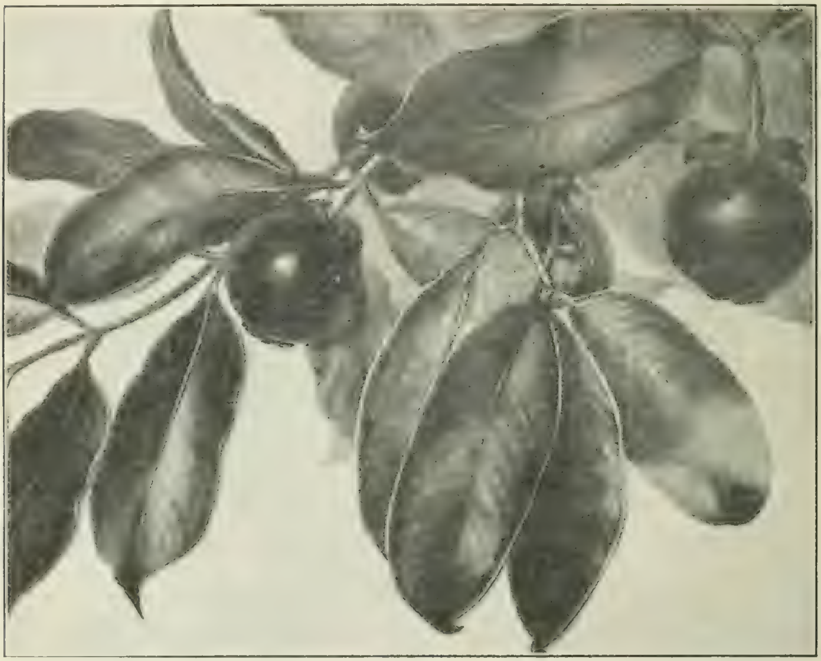

FIG. 11.—Fruiting branch of the mangosteen. (From a painting by Miss D. G. Passmore.)

The inarched trees recently planted in the Panama Canal Zone by the Bureau of Plant Industry have turned out well, and it is hoped that not only the proper method of propagation has been discovered, but also that a suitable place has been found where the mangosteen may be grown on a large scale and the fruit be more commonly seen in this country.

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[a] See Woodrow, G. M., Gardening in India, 1888, p. 155, and Harris, W., Bulletin of the Botanical Department, Jamaica, no. 9, November, 1888, p. 3.

DIFFICULTY IN GROWING THE MANGOSTEEN FROM SEEDS.

The cause of the difficulty in rearing young seedlings of the mangosteen has not been fully determined. Several experiments carried out from the gardener's standpoint to ascertain the cause have produced negative results. It is known that the most precarious period in the life of the mangosteen tree is the seedling stage, but even with seedlings the results of careful treatment are by no means uniform. When a comparatively large number are given the same soil, temperature, etc., all grow well until they are about 3 inches above the surface of the soil. After that period, when grown on their own roots, sometimes two-thirds of the number will either remain in a stunted condition or the leaves subsequently developed will have a yellowish-brown color.[a]

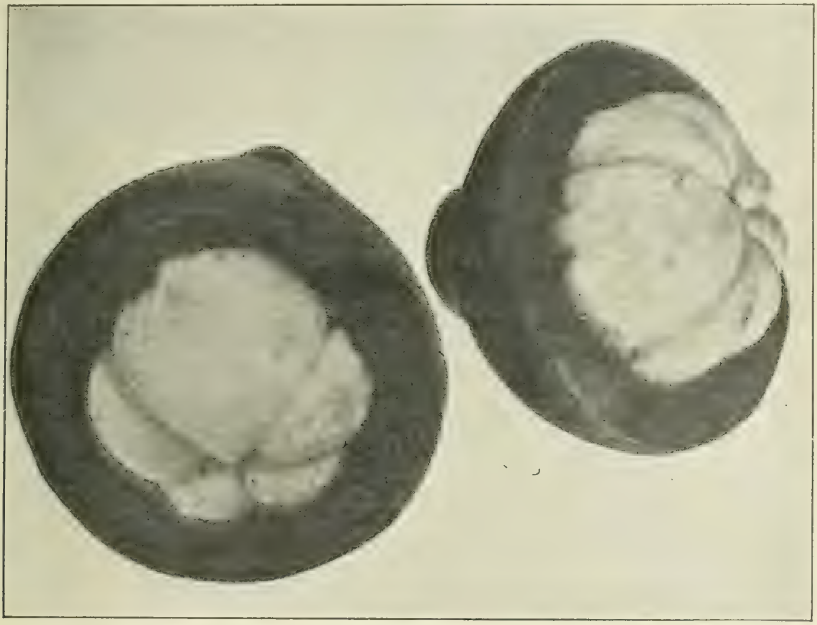

FIG. 12.—Mangosteen fruits cut open, showing the white edible interior.

It seems to be the experience of cultivators in Ceylon, India, and the West Indies that when the leaves of a mangosteen seedling assume a sickly appearance there is little or no hope for the future health of the plant. This belief accords with the behavior of the first lot of seedlings in the greenhouses of the Department of Agriculture. The roots of these sickly-looking specimens when examined superficially appeared fairly healthy, but whether at the beginning the trouble is with the roots or with the leaves has not yet been determined. It is known, however, that when the seedling depends on its own roots it is impossible to get those affected seedlings to develop healthy leaves above the sickly ones. The difficulty has been repeatedly overcome (in fact in every instance) when the sickly seedling is inarched to some strong-rooted species of the same genus.

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[a] "The mangosteen fruit seldom produces more than one or two seeds. These grow readily, but, so far as we are aware, few trees have been established from them. Our experience shows that after appearing above ground the seedling grows freely for one or two years, but afterwards generally assumes a sickly appearance and gradually dies out." Bulletin of Miscellaneous Information, Royal Botanical Garden, Trinidad, January, 1895, vol. 2, no. 1, p. 10.

Plate VI, figure 1, shows an inarched seedling mangosteen in which the two terminal leaves did not develop; furthermore, the leaves below the terminal ones died and after inarching all the growth above the first pair of leaves gradually succumbed, but the dormant buds lower down on the seedling developed the two healthy growths shown in the illustration (Pl. VI, fig. 1, *A*). It must not be inferred from this experience that this is the only method of propagating the mangosteen—or even a desirable method, for that matter. This point will be made clear in the description of the nurse-plant method of propagation (p. 32).

CARE OF MANGOSTEEN SEEDLINGS WHILE GROWING IN POTS.

Few plants show the results of inattention on the part of the cultivator more plainly than the mangosteen. When once a plant becomes in the least sickly, there is little likelihood of its recovery on its own roots. The mangosteen does not take kindly to heavy soils; it prefers a well-drained soil containing a large proportion of decayed vegetable matter. When seedlings are removed from flats and put in pots some will die without apparent cause. An oversupply of water causing the soil to become in the least sour is certain to induce sickness much more quickly in the mangosteen than in other species of the genus. Therefore, great care is necessary in handling the plants, especially in the early stages of the seedlings.

THE ROOT SYSTEM OF THE MANGOSTEEN COMPARED WITH OTHER SPECIES OF GARCINIA.

Unfortunately the mangosteen is not a strong-rooting plant, especially during the first year or two after germination. This peculiarity renders it particularly sensitive to dry weather and may account in part for the many failures to grow it successfully. Nearly all the other species of the genus have strong and abundant roots, even in the seedling stages. It therefore seems likely that the mangosteen will thrive better and under more widely varying soil and atmospheric conditions if the young plant is inarched to some species of the genus which has a good root system.

PROPAGATION BY THE ORDINARY METHOD OF INARCHING.

When the ordinary method of grafting is employed or when mature branches of the mangosteen are inarched to stocks of some of the large-leaved species of Garcinia, unions are obtained which appear quite firm and evidently successful, but the differences in texture between the woods of stock and scion are too great for good unions to be effected. The lateral shoots or small branches of young trees of the mangosteen 3 to 4 feet in height have been tried repeatedly; but the wood of the mangosteen growths does not attain that requisite hard consistency which we get in seedling Garcinias of other species, varying in size from a few inches to 1½ feet in height. The wood of these seedlings is comparatively hard and gives a rapid and satisfactory callus; the branches of larger mangosteen plants on the other hand are green and comparatively soft, and the inarches, after being gradually severed from the parent mangosteens, look fairly promising for a day or two, but notwithstanding the best of care they droop and shrivel. Further experiments with shoots of larger mangosteen plants are now in progress to ascertain the result of delaying the severance of the mangosteen shoots from the mother tree, ranging from a period of six weeks to one of three to six months. The sound appearance of some of the unions indicates that this method may be successful.

CONDITION OF THE WOOD OF SEEDLING MANGOSTEENS.

The texture of the stems of the seedling mangosteens 3 to 4 months old is firmer than that of lateral branches of seedlings 3 to 4 feet high, and at the earlier stage is admirably adapted for inarching; in fact, when united to a strong-growing plant of any of the larger leaved species of Garcinia, the union is rapid and very satisfactory. Seedlings of the mangosteen with stems averaging one-sixth of an inch in diameter at the time of inarching have increased within three months to half an inch in diameter.

STOCK PLANTS FOR THE MANGOSTEEN.

The mangosteen (*Garcinia mangostana*) belongs to the natural family Guttiferæ. The genus Garcinia is a large one, the Index Kewensis listing 228 species. Of these species about 20 have been tried in the inarching experiments; and while the mangosteen unites with all of them, only a few can be recommended as promising stock plants. Two other genera of the same family, Calophyllum and Platonia, have been tried. Two species of Calophyllum, *C. calaba* and *C. inophyllum*, are not satisfactory because the union between these and the mangosteen is imperfect. This is partly because the stems of the Calophyllums are softer than those of the seedling mangosteen and partly because the growth made by the former as they become older is much more rapid. *Platonia insignis* (Pl. VI, fig. 2), on the other hand, so far as the experimental work has progressed, is a very promising stock from one to three years after germination, and if it will grow under the conditions suitable for the mangosteen, it may turn out to be the best stock of all those tried. The most promising species of Garcinia for use as stock plants for the mangosteen are *G. tinctoria* (fig. 13), *G. morella,* and *G. livingstonei,* in the order named, the last a native of Portuguese East Africa. The two first named are from the Malay Peninsula.

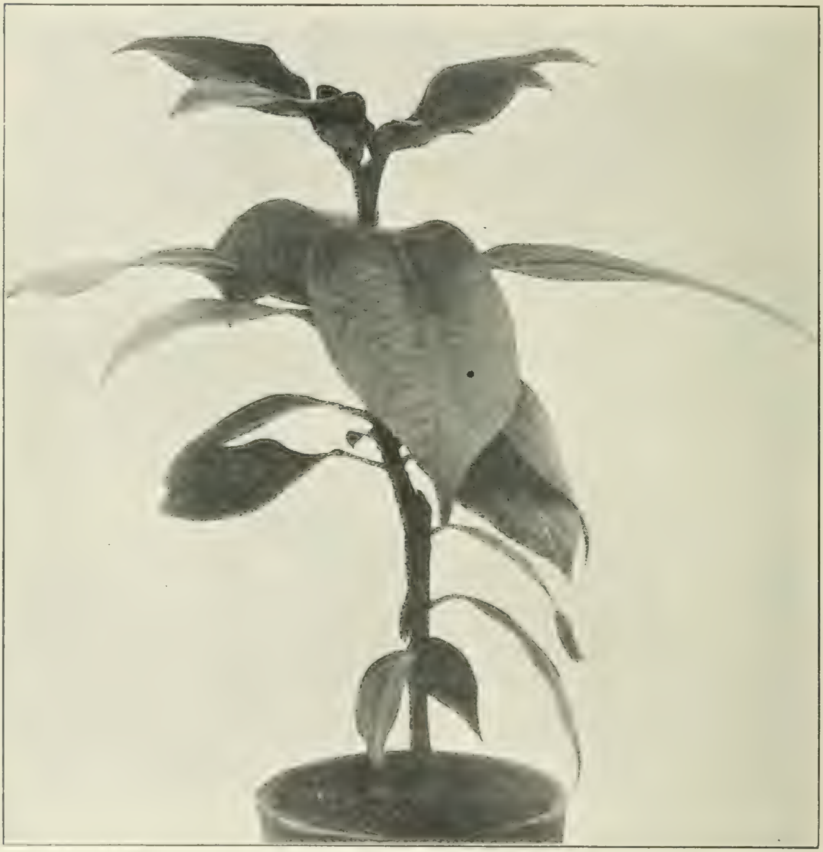

FIG. 13.—Mangosteen seedling inarched on *Garcinia tinctoria* with foliage of stock plant opposite and below the union. Height of seedling at time of inarching, about 10 inches.

The list of species of Garcinia experimented with is as follows: *G. cornea, G. hanburyi, G. morella, G. tinctoria,* and *G. spicata,* from the Malay Peninsula; *G. binucao, G. cowa,* and *G. indica,* from India; *G. livingstonei,* from Portugese East Africa; *G. speciosa,* from Burma; *G. loureiri* and *G. sizygiifolia,* from Borneo; and *G. fusca,* from Siam. It is quite possible that several other species of Garcinia may be even more valuable as stock plants, and also that some species of the related genera may prove desirable, but other material than that mentioned has not been available in the work. All the promising species ought to be tried whenever there is an opportunity. Some species of Garcinia lately found in the Philippine Islands would seem to be promising mangosteen stocks, especially those said to grow under widely varying conditions.

GROWING SEEDLING STOCKS.

None of the species of Garcinia used as stocks are difficult to raise from seeds, provided they are fresh. They are easiest to germinate when sown in soil composed largely of partially decomposed leaves mixed with a little loam and rough-grained sand. They should be potted as soon as the first leaves are well developed. All the Garcinias with the exception of *G. mangostana* have magnificent root systems and they thrive under ordinary treatment in so far as soil watering and a considerable range of temperature are concerned.

It is an important point to have the stock plants in an active stage of growth when the union is in progress, though the seedling mangosteens may be inarched while apparently dormant. Although the unions when both stock and scion are in a resting stage are fairly satisfactory, the difference in growth is easily observable when the stock plants are in active growth. To secure this active growth the stocks should be allowed to become dormant; then, when they are given larger pots, good drainage, and soil composed of rotted leaves, at least one-half, and the rest fibrous loam containing a little rough-grained sand, together with some rough charcoal and crushed bone, they will under high temperature respond with vigorous growth. When inarched in this condition the union is always satisfactory.

All plants used as stocks have been from one to three years old. Within that period the age of the stocks seems to make little difference, especially when used as nurse stocks. Mangosteen seedlings seven months old united on nurse stocks of 3-year-old *Garcinia tinctoria* made very fine unions (Pl. VII), and within six months after the union some of the mangosteen stems were almost as thick as those of the stocks.

PREPARING SEEDLINGS FOR INARCHING.

The propagation of seedling mangosteens for inarching on the stems of seedling stocks of other species of Garcinia (fig. 13) does not differ materially from that operation as described for seedlings of the mango (p. 15). The most important difference to be observed is that the roots of the mangosteen need to be kept alive only long enough to give partial support to the seedling while the union is taking place. In the inarched mango the roots of the seedling are very carefully tended because they are to become the roots of the future mango tree. To insure sufficient moisture, place around the ball of the seedling fresh sphagnum moss mixed with twice the quantity of partly decayed leaves. Keep this material in position around the roots of the seedling with a piece of cloth which will absorb water readily. The seedling may be supported with a piece of $\frac{1}{8}$-inch galvanized-iron wire while the union is taking place.

MAKING THE INARCH.

Place the stem of the seedling mangosteen close to that part of the stem of the stock where it is desired to make the union, then tie the root of the seedling inclosed in a piece of sacking to the stem of the stock plant with a strand of raffia. After making the tie, and before cutting the ends of the strand of raffia, put in the wire support and make secure with raffia. Cut a slice from the stem of the stock, going into the stem about one-third of its diameter. The length of the slice is regulated by the length of available stem in the seedling; 2 inches is desirable, but less will suffice. Next remove a piece of the stem of the seedling exactly opposite the cut in the stock, exercising extreme care in making one side of the cut on the scion fit evenly with one side of the cut on the stock. Pay no attention to the other edges of stock and scion, but bind firmly together and the operation is complete. If the inarching is performed in summer, and this seems the best time, make a puddle of adhesive clay, mixing it with some raw cotton which has been cut up fine with a pair of shears; apply this around the parts to be united and allow it to dry. The clay serves two purposes—it excludes air and it absorbs all the sap exuded from the cut portions. The raw cotton prevents the puddled clay from disintegrating while the union is taking place.

It is well that the point of union should be so chosen that a few leaves of the stock plant may be left growing below the union (fig. 13) after the top of the stock and the roots of the seedling have been removed. If the union is near the base of the stock and below the foliage the subsequent growth made by the inarched seedling mangosteen after being separated from its roots is not so rapid nor so robust as it is when placed farther up the stem and above a few of the leaves. When mangosteen seedlings are inarched on nurse stocks the conditions are different, and the union is made as low on the stock as possible (Pl. VI, fig. 2, *C*).

REMOVING THE TOPS OF THE STOCKS AND THE ROOTS OF SEEDLING MANGOSTEENS AFTER A UNION HAS BEEN EFFECTED.

After the seedling mangosteens have become united with the stock plants the tops of the stocks should be gradually severed above the union. A notch may be made in the stem of the stock immediately above the union and on the side of the stem opposite to it. Ten days afterwards the top may be removed altogether.

When seedling mangosteens are inarched with the intention of removing the roots after the union is perfect, the soil around the roots, held in position by the piece of cloth, should be allowed only a small quantity of water for a period of about two weeks after the tops of the stocks have been removed, then the stem of the mangosteen seedling may be gradually severed immediately below the union. Any leaves on the stem of the stock plant below the top of the united parts (fig. 13) may be allowed to remain, as they are helpful in keeping the inarched seedling in a healthy condition till the time arrives when it will make large leaves of its own. But in the nurse-plant method it does not seem necessary to allow any of the leaves to remain on the stock.

INARCHED MANGOSTEEN SEEDLINGS REESTABLISHING THEIR OWN ROOT SYSTEMS.

During the progress of the experiments in inarching the mangosteen several of the inarched plants exhibited a peculiar characteristic which up to that time had not been noticed in any other inarched plant. About eighteen months after 1-year-old mangosteen seedlings were apparently united to *Garcinia tinctoria*, as well as to other species, and long after the root and part of the stem of the mangosteen seedling, together with the top of the stock, had been severed and the mangosteen had made splendid growth, as evidenced by large, well-formed, and deep-green leaves, each suddenly developed a very thick aerial root at the base of the inarched stem of the mangosteen (Pl. VIII, fig. 2). This root became elongated and pierced the soil several inches below the point at which the roots first appeared, apparently making very rapid progress after reaching the soil. About two months afterwards the extra rapid growth of the new leaves was pronounced. In one or two instances the stock plants on which the mangosteens were inarched began to decay; the dissolution was rapid, and in a few months from the appearance of the aerial roots the rebellious mangosteens were again on their own roots, looking strong and healthy (Pl. VIII, fig. 1).

The behavior of the inarched seedlings in reestablishing their own root systems strongly suggests noncongeniality of the scion to the stock; but that this is not true is proved by the behavior of those mangosteens propagated by the nurse-plant system. Moreover, it has been found that the stems of seedlings when inarched at a point 2 or 3 inches above the first pair of leaves on the stocks, as seen in figure 13, evidently make permanent unions; at least, there has been no attempt on the part of the scions to produce roots, and the stems of the stocks have increased considerably in girth since the unions took place. As further evidence that the formation of roots at the base of the inarched branch is not due to noncongeniality of stock to scion it may be mentioned that the bases of the inarched branches of litchi when inarched on seedlings of the same species form roots very freely. Especially when the branch is severed an inch or two from the lower part of the union, and the cut surface touches the soil, roots are always formed abundantly. It has been possible in numerous instances, after these roots have made considerable headway, to obtain a second plant as a result of this characteristic by severing the stem after rooting at a point as near the base of the inarched part as possible.

During the early part of 1909 the idea suggested itself that this peculiar feature in the behavior of inarched mangosteen plants described above might be used to bring the seedlings through the earlier and crucial stages of their existence. So far as our work has gone the results are exceedingly satisfactory, and the new method may be termed the nurse-plant system of propagation.

THE NURSE-PLANT SYSTEM OF PROPAGATING THE MANGOSTEEN.

About thirty seedlings of the mangosteen, averaging 4 inches in height, were available for taking advantage of the lesson taught by the behavior of the inarched plants described above. All of these seedlings were beginning to show in their foliage signs of sickness. They were carefully removed from the 3-inch pots in which they had been growing, the soil was washed from the roots in tepid water, and each seedling was planted in a 6-inch pot containing a healthy 2-year-old plant of *Garcinia tinctoria*. Each mangosteen was planted as close to the nurse plant as possible without destroying its roots, so that inarching could be easily performed after the mangosteen showed signs of recovering from any slight setback resulting from its removal. The plants were placed in a humid atmosphere with the temperature ranging from 70° at night to 90° F. during the day. Three weeks after the seedlings were placed in the pots containing their prospective stocks they showed a slight improvement. They were then carefully inarched, and within six weeks the improved appearance of all the seedlings indicated that successful unions had taken place (fig. 14). The tops of the stock plants were then removed. The subsequent progress made by the mangosteens on nurse stocks has been in many instances greater than that made by seedlings inarched by the ordinary method (Pl. VII). Several of these mangosteens worked by the nurse-plant method have been sent to the Canal Zone and are reported to be doing well. The remaining ones still in the greenhouse continue to make good growth, but the stems of the stock plants do not show as much increase in diameter as do those of the mangosteens attached to them (fig. 14).

In some instances the roots of the nurse plants show no appreciable cessation of growth after the tops of the plants have been removed. One would expect that in such event the roots of the inarched mangosteen seedlings would not be well developed, but as a matter of fact they are much superior to those of an uninarched seedling of the same age (Pl. VII), proving that as a result of the union the mangosteen is nursed along during the critical period of its existence in a most satisfactory way. This undoubtedly indicates that the mangosteen needs treatment of this nature to bring it through the early seedling stages, because the roots of the uninarched seedlings, especially within a year after germinating, are never robust, and too much or too little water produces bad effects. Those plants, however, which were inarched on other species of Garcinia by the seedling-inarch method seem to thrive well when subjected to the treatment usually accorded inarched mangos.

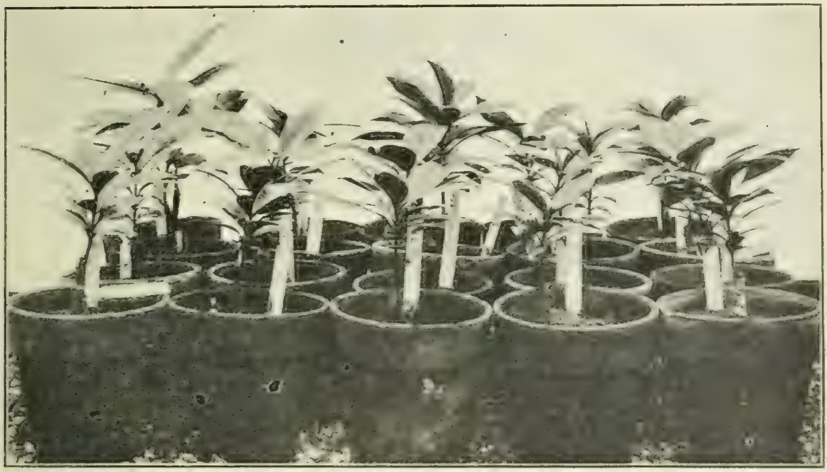

FIG. 14.—Group of mangosteen seedlings inarched by the nurse-plant method. The tops of the nurse plants have been removed.

Although our experiments in inarching the mangosteen on nurse plants have turned out very satisfactorily, not a plant being lost, the method first used has been improved considerably, so that there is now less danger from careless work. The nurse plants of *Garcinia tinctoria* should be grown in small-sized pots, not larger than 4 inches, previous to placing them in the 6-inch size. When getting their final shift the ball should be manipulated so that the stem of the seedling will be a little to one side so as to make room for an empty 3-inch pot to be placed in the soil beside the stock plant (Pl. VI, fig. 2, *A*). When the stock plant is established in the soil, after perhaps three or four weeks, that is, when the new roots have had time to develop, the empty 3-inch pot is removed (Pl. VI, fig. 1, *B*) and the root of a mangosteen taken from a pot of the same dimensions is placed in the empty space and the soil carefully but firmly rammed around it. Generous treatment will result in further development of the root action of both mangosteen and nurse stock. They are then inarched (Pl. VI, fig. 1, *C*), and when the union is satisfactory, which will be in about five weeks, the top part of the stock above the inarch may be gradually removed. The roots of both nurse plant and scion are left undisturbed because, if the stock dies, the root system of the seedling mangosteen will probably have become strong enough to sustain the plant by reason of the assistance given to it by the nurse plant during its precarious stage; and if, on the other hand, the roots of the seedling succumb, it probably will be due to the fact that the stock is supplying enough root action for the mangosteen.

FUTURE STAGES OF GROWTH.

It should be distinctly understood that certainty of success with either method, in so far as it relates to the future stages of growth of the mangosteen, is by no means guaranteed when the plants are put in place in the open. All that it is intended to claim is that the method is a promising one on account of the rapid progress made by the seedlings after the union takes place. The seedlings which have been inarched have not as yet had time to make sufficient progress to demonstrate that they will grow rapidly on the stocks used; but it has been thought best to make public the discovery of this method as soon as possible, in order that experimenters may try it with a large number of different stocks. The mangosteen, however, is well known to be a rebellious subject; and beyond the union of its seedlings with older stocks of different species nothing has been accomplished.

PACKING SEEDS FOR SHIPMENT.

It has been found that mangosteen seeds received in numerous shipments from various parts of tropical Asia do not retain their vitality for any considerable length of time, probably on account of unsuitable packing material or of improper packing. Most of the shipments have arrived without a trace of life in the seeds, a condition due to the packing material in the tin mailing tubes being too wet. Sometimes the seeds arrived in dampened moss and sawdust, mixed in equal parts. Other shipments were received packed in each of these materials, sometimes wet, at other times dry; but as yet we have never received a successful shipment when these materials were used, whether wet or dry. The best shipment came from Ceylon a few years ago, packed in comparatively dry, powdered charcoal. From that particular shipment nearly every seed sprouted. The charcoal when weighed immediately after the seeds were removed and again when sundried, showed a difference of less than half an ounce to the pound. It sometimes happens that the tin mailing tubes, frequently less than 2 inches in diameter, are so placed en route that they are subjected to high temperatures and the seeds are thus injured.

PRELIMINARY TREATMENT AND SOWING OF THE SEEDS.

The seeds should be carefully looked after the moment they arrive. If any of them have made an effort to germinate en route while still in the charcoal, owing to some of the fleshy part of the fruit adhering to them when they were shipped, they should be handled with very great care, as the soft protruding parts are very susceptible to injury. Washing them in tepid water will partly remove some of the deleterious matter surrounding them. Before they become dry they should be dusted with powdered charcoal and immediately planted one at a time in a flat of leaf soil made quite firm. The germinating medium may be prepared beforehand when a shipment of seeds is expected. It should not be gathered promiscuously from the woods, as it is then liable to contain deleterious matter. Beech leaves about a year old, chopped very fine, with a small quantity of rough-grained sand and a little charcoal added, will give a very satisfactory germinating medium. When the seeds have begun to sprout en route, they should not be pressed into the material, but each one should be arranged with the sprouted part occupying a slight depression on the surface of the soil and covered with half an inch of the material. The leaf soil should be placed in a wooden flat and the top of the box covered with panes of glass, so that a humid atmosphere may be constantly maintained. The temperature of the greenhouse should range from 75° F. at night to much higher in the daytime and the seed box should be protected from direct sunlight.

The seedlings will thrive in the seed flat until they are about 2½ inches above the surface. They may then be potted off singly in 2½-inch or 3-inch pots, with good drainage. In potting, material should be used similar to that recommended for germination, with a very small quantity of mellow loam added. Coconut fiber or even thoroughly rotted wood may be mixed with it, care being taken that it is free from deleterious fungi. If leaf soil is not available, coconut fiber is very good, but great care is necessary in watering, as the fiber holds water like a sponge. Thus a 5-inch pot will hold 6 ounces of dry fiber when firmly pressed down, but twenty-four hours after being saturated the fiber will weigh 19 ounces. It not only holds more water than most other substances, but it holds it longer, and it is this peculiarity which makes it one of the best media for germinating purposes, that is, provided the attendant is able to judge accurately of its water content.

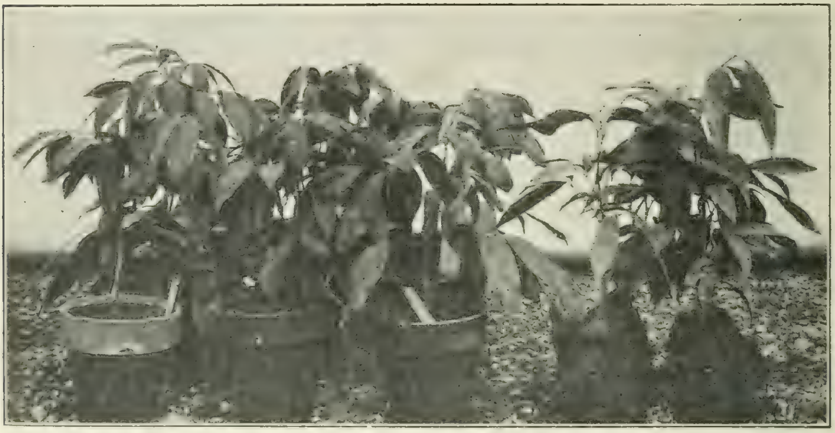

Fig. 15.—Group of inarched litchi plants, also seedling litchi stocks prepared for inarching.

PROPAGATING VARIETIES OF LITCHI BY THE SEEDLING-INARCH METHOD.

Plants of one of the finer varieties of litchi (*Litchi chinensis*) were obtained from China two years ago. They are said to be propagated in that country partly by layering and partly by notching large branches, and covering the wounds with a quantity of soil kept moist. When roots are at length produced, the branches are removed from the tree, trimmed, and put in receptacles until time for planting; but during the period of propagation the percentage of loss is said to be large. The propagation of these plants by the seedling-inarch method has been very successful (fig. 15). The Chinese, or litchi, nuts, as they are called (Pl. IX), offered for sale in the fruit stores of this country are dried previous to their importation and therefore are useless for the purpose of raising young plants. The Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry obtained a small consignment of untreated litchi seeds from China about eighteen months ago, all of which germinated. The plants thus obtained proved to be the best stocks to use. Young branches of the improved variety of the litchi were inarched on these seedlings, every one making a very successful union. They were subsequently distributed. Many hundreds of plants could be propagated annually from the plants of this variety of the litchi now in the greenhouse if seedling litchi stocks were available for inarching. The next best stock is the longan (*Euphoria longan*), but while the unions are fairly successful on this species, they are slower than with the litchi stocks.

The litchi as a fruit-producing plant is at its best in China when grown in comparatively wet ground and in soil consisting largely of decomposed vegetable matter. It probably would succeed admirably in the Everglades of Florida in places where there is little likelihood of exposure to a temperature lower than 30° F. In California the tree does not look happy, but all of those recently seen by the writer were in dry, loamy soil. The Canal Zone and Porto Rico will probably prove congenial homes for this fruit tree. The fruits sent to the United States are not of the best varieties, being small, seldom more than an inch in diameter. The finer varieties are said to bear much larger fruit.

The method of propagation in its essential features is like that described for the mango (p. 14). The seedlings to be used as stocks are taken from 3-inch pots, the soil on the upper part of the ball removed, and a large handful of coconut fiber secured around the roots by wrapping in a piece of sacking about 8 inches square. These seedling stocks are fastened to the stout branches of the parent litchi or to stakes set in the soil of the pot. The branchlets are then inarched to the seedlings and tied with raffia, and the parts to be united are covered with clay. During the few weeks occupied in uniting, the roots of the seedlings make rapid headway in the coconut fiber. The unions are invariably good when seedlings of the same species are used. If the compound leaves on the scion are large it is advisable to trim them back slightly before severing the inarch from the parent tree. After severing, the inarched plants may be potted and placed in a close frame in the greenhouse, or they may be put in shallow boxes and the roots covered with coconut fiber, the atmosphere being kept moist. The sacking should not be removed, because, when the scions have united, the white roots of the seedlings will be found to have pierced the covering, so that to remove this sacking would necessarily injure the roots. The balls should be put in 5-inch or 6-inch pots, as may be necessary; the soil should consist mainly of decomposed leaves.

It is a peculiarity of the litchi that it makes several flushes or growths in a season; therefore, material for propagation is abundant even in a small tree. Seedling stocks have been used when the stems were not over one-eighth of an inch in diameter and from that to one-fourth of an inch, the latter thickness giving the best results.

PROPAGATING THE RAMBUTAN.

The rambutan (*Nephelium lappaceum*), said by some of the inhabitants of Java and elsewhere to produce a fruit even more delicious than that of the mangosteen, is amenable to rapid propagation if the young shoots are united to seedling stocks of the longan (*Euphoria longan*). It is thought that the Canal Zone will supply the necessary conditions for the successful cultivation of this tree. It is said that there are several varieties, and if it is possible to import vegetatively propagated plants of these varieties successfully, as was done with the litchi, their rapid multiplication in this country will be assured.

SUMMARY.

It will be observed from the foregoing descriptions of the improved methods of propagating the mango, the mangosteen, and the litchi that practically the same method is employed with each; the uniting of a comparatively young seedling with a shoot of an approved variety of mango; the uniting of mangosteen seedlings with different species of the genus to which the mangosteen belongs, and even with species of different genera of the same family; and the uniting of shoots of approved varieties of litchi with seedling stocks or with seedlings of other species of the same genus.

Seedlings not more than a few months old are always used. The mango and litchi seedlings are used as stocks only, but the mangosteen seedlings are used as scions.

The operation with each kind of plant is a decided success. The method is so simple that it can be used by a person having no previous experience in the propagation of plants. It saves much of the time necessarily spent with the older methods. The worked plants are healthier and the operation is many times cheaper than the older methods.

PLATES.

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DESCRIPTION OF PLATES.

Plate I. Fig. 1.—Australian finger lime (*Citrus australasica*) inarched on lemon stock when a 5-weeks-old seedling; shown in text figures 5 and 6. In bearing only two years after the germination of the seed. The fruits are the result of cross-pollination with the so-called Panama orange. Fig. 2.—Crossed seedling of Australian finger lime and the Panama orange, grown from seed of fruit shown in figure 1. One of 13 seedlings showing hybrid characters in increased size of leaves and slightly winged and elongated petioles. This seedling was inarched three weeks after germination to a 2-year-old lemon stock. The top of the stock plant has been removed and the root of the seedling is ready to be severed. Time taken to form union, three weeks.

Plate II.—Germination of mango. Seed with 8 sprouts, six weeks after planting. The two strongest sprouts should be selected for stocks and potted, the others discarded.

Plate III. Fig. 1.—Mango seedling stock fastened to branch of tree of an approved variety, ready for inarching. The cuts in scion and stock are shown at *A* and *B*. Fig. 2.—Mango seedling with scion of approved variety tied in position. If conditions are favorable, a union will be effected in about thirty days.

Plate IV. Fig. 1.—Inarched mango. The top of the seedling stock above the union has been gradually removed, and the shoot of the approved variety has also been gradually severed from the parent tree. Fig. 2.—Inarched mango in 5-inch pot. The sacking inclosing the roots is carefully removed unless the roots show outside the sacking, in which case the ball is placed in a 5-inch pot and fresh soil rammed firmly between the ball and side of the pot.

Plate V. Fig. 1.—Mulgoba mango growing at Mangonia, Fla. This is the original tree of this variety introduced into Florida by the Department of Agriculture in 1889. This tree having numerous branches near the ground shows how easy it would be to inarch a very large number of shoots by the method here described. Fig. 2.—Bench of newly inarched mangos. After potting they are shaded from the sun and the atmosphere kept humid for a few days.

Plate VI. Fig. 1.—Sickly mangosteen restored to health by inarching on *Garcinia tinctoria*. The original stem of the seedling, which had lost its upper leaves before being inarched, is shown at *A*. After the union took place both of the lateral shoots seen in the illustration developed and the top of the seedling died. The plant afterwards made fine growth. Fig. 2.—Inarching the mangosteen by the nurse-plant method, showing empty 3-inch pot inserted in soil when potting. Empty pot removed, leaving space for root of seedling from a 3-inch pot. Root of seedling mangosteen from 3-inch pot inserted in space provided for it and inarched to nurse stock plant of *Platonia insignis*.

Plate VII. The nurse-plant system of propagating the mangosteen. The seedling was inarched to a plant of *Garcinia tinctoria* when the former was about 3 inches high and in a sickly condition. The roots of both stock and scion are developing satisfactorily. The plant represented was taken from a 6-inch pot.

Plate VIII. Fig. 1.—Inarched mangosteen reestablishing its own root system. *A*, scar showing where it was inarched to a seedling of *Garcinia tinctoria; B*, point showing where the new root formed some time after the union took place previous to the rejection of the stock. Fig. 2.—Mangosteen developing a large root after it had been inarched to another species of Garcinia. The stock in this instance shows no signs of decay.

Plate IX. Fruiting branch of litchi (*Litchi chinensis*). Two-thirds natural size.

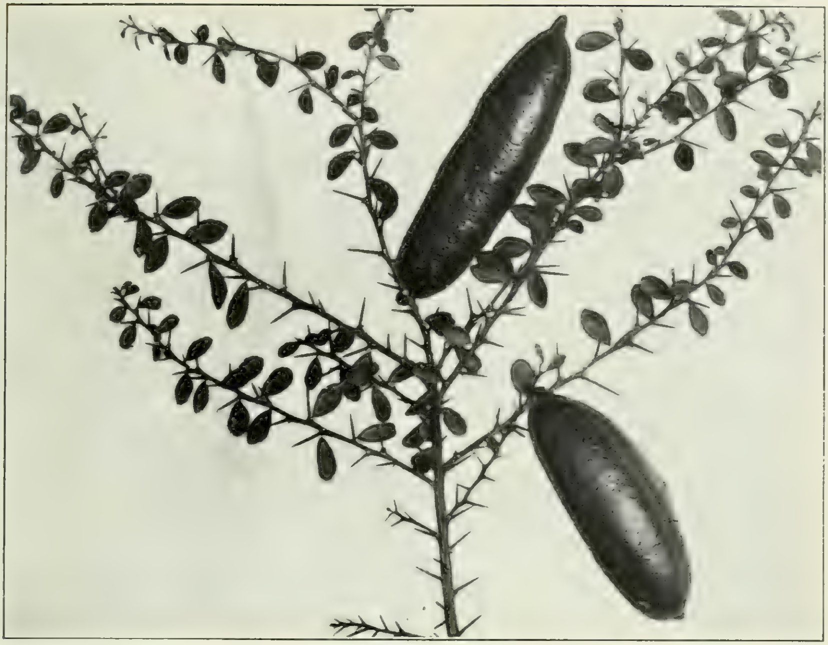


FIG. 1.—CITRUS AUSTRALASICA, BEARING FRUIT TWO YEARS AFTER THE GERMINATION OF THE SEED.

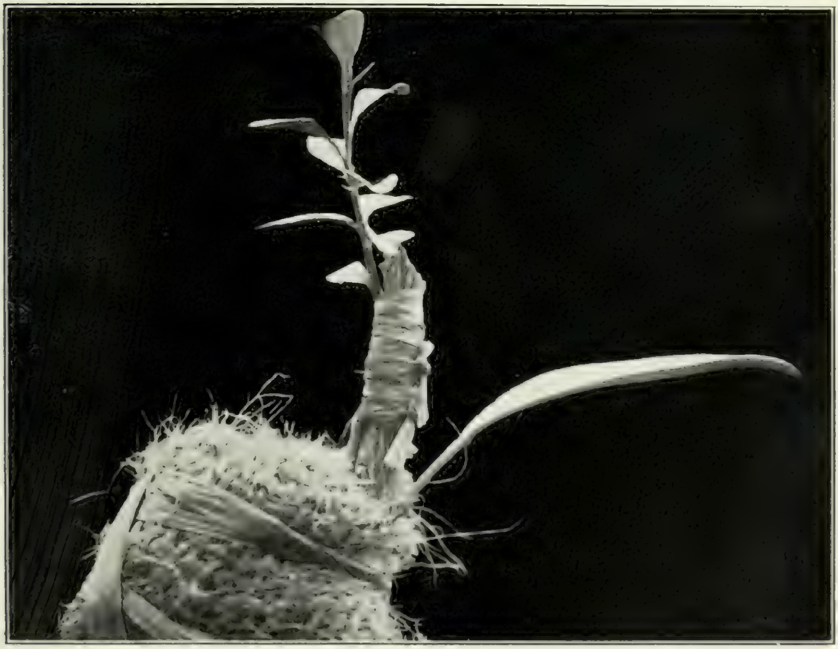
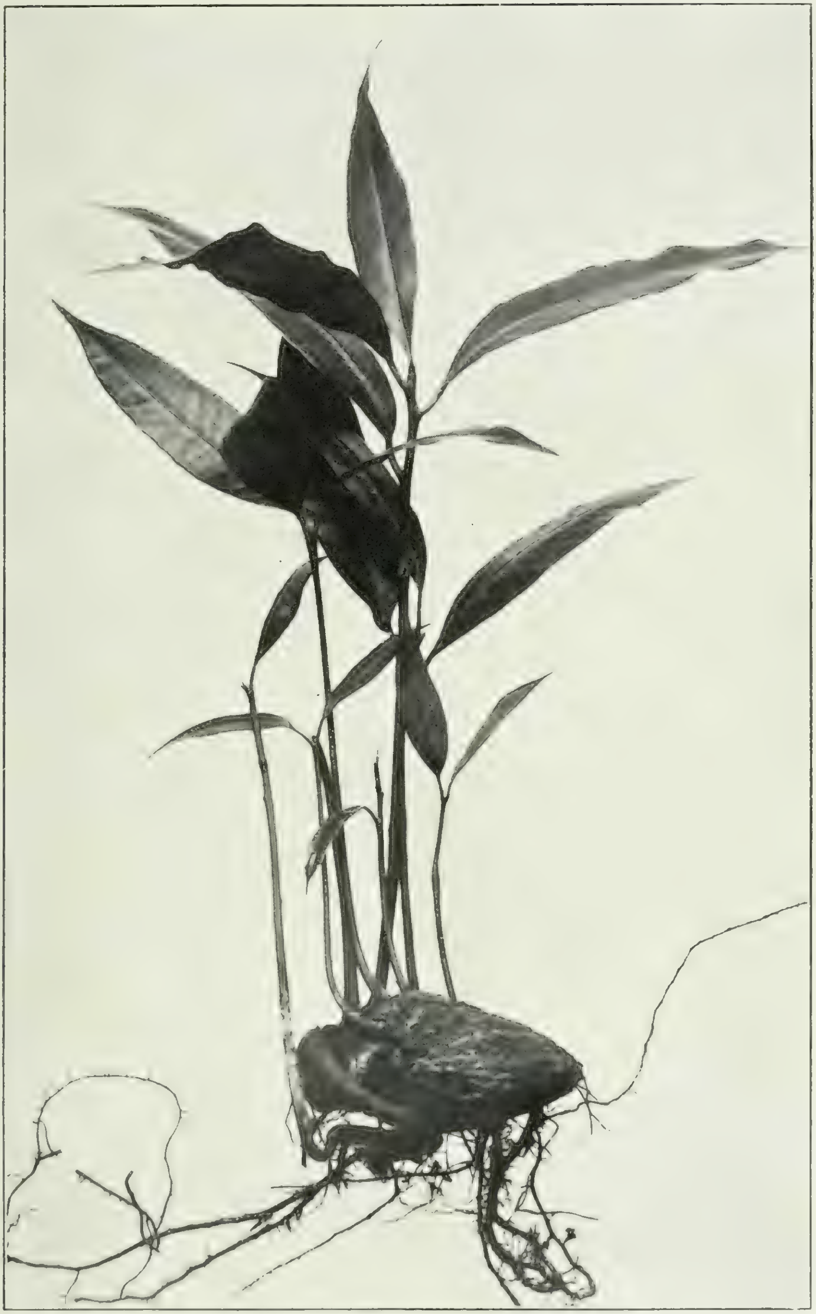


FIG. 2.—CITRUS AUSTRALASICA × C. MITIS, GROWN FROM FRUIT SHOWN IN FIGURE 1.



MANGO SEED WITH EIGHT SPROUTS.

(One-half natural size.)

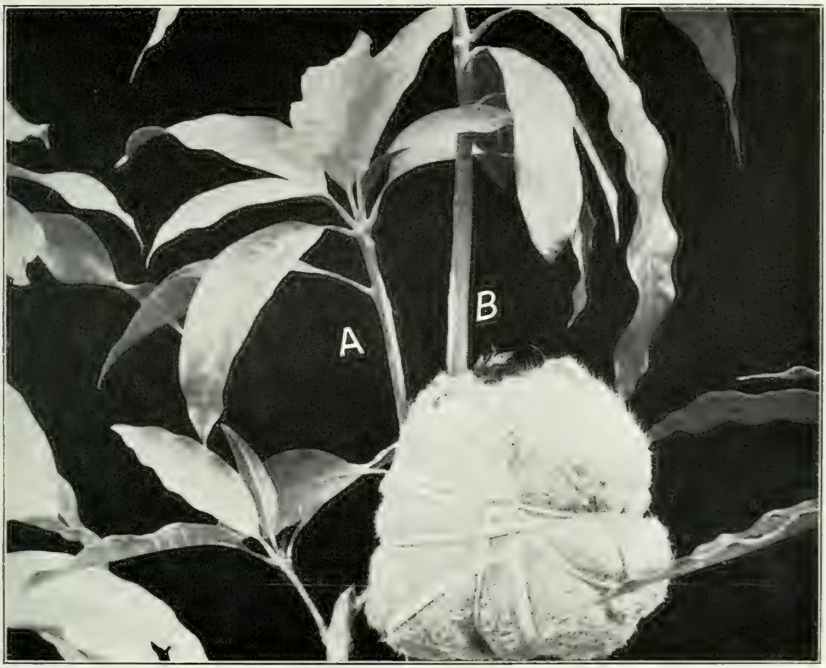


FIG. 1.—MANGO SEEDLING ATTACHED TO TREE, SHOWING CUTS IN STEMS OF SCION AND SEEDLING.

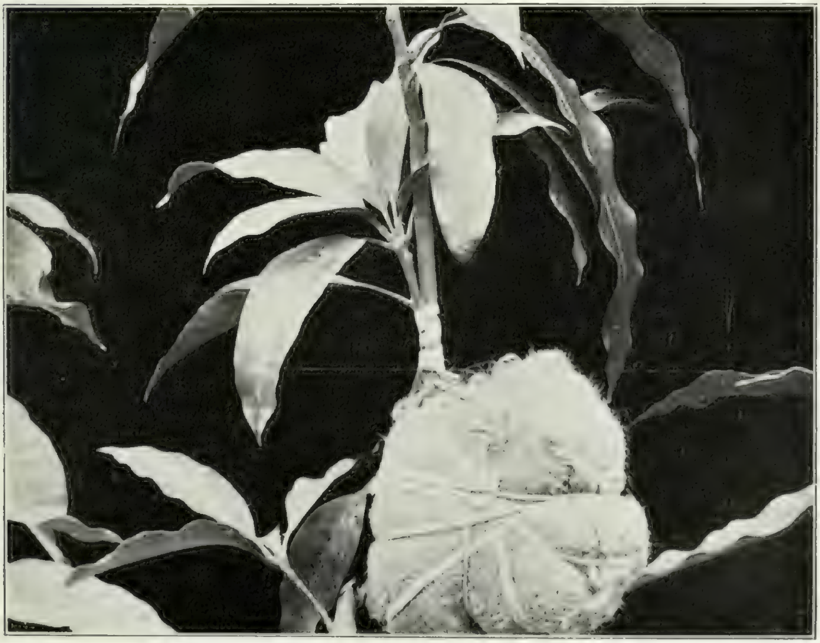


FIG. 2.—MANGO SEEDLING AND SCION IN PLACE.

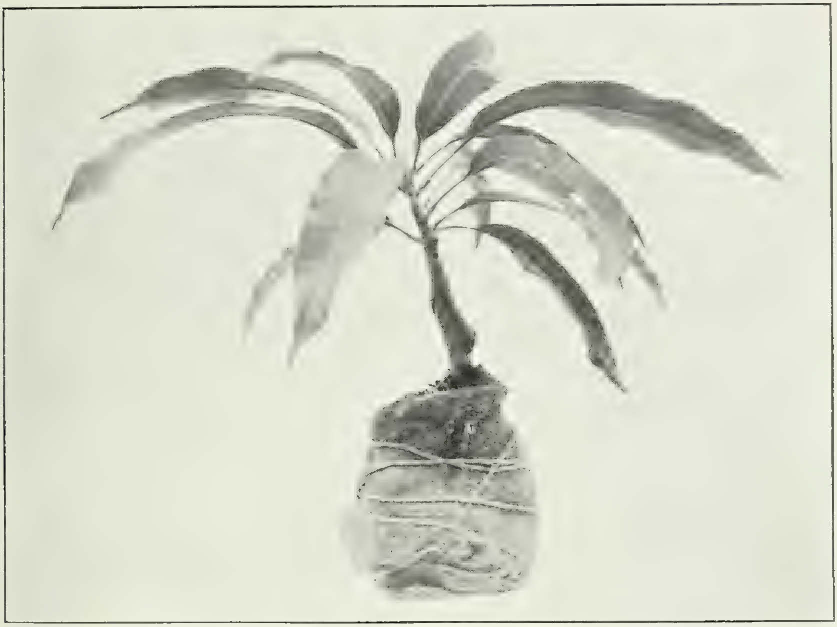


FIG. 1.—INARCHED MANGO AFTER BEING SEVERED FROM PARENT TREE.

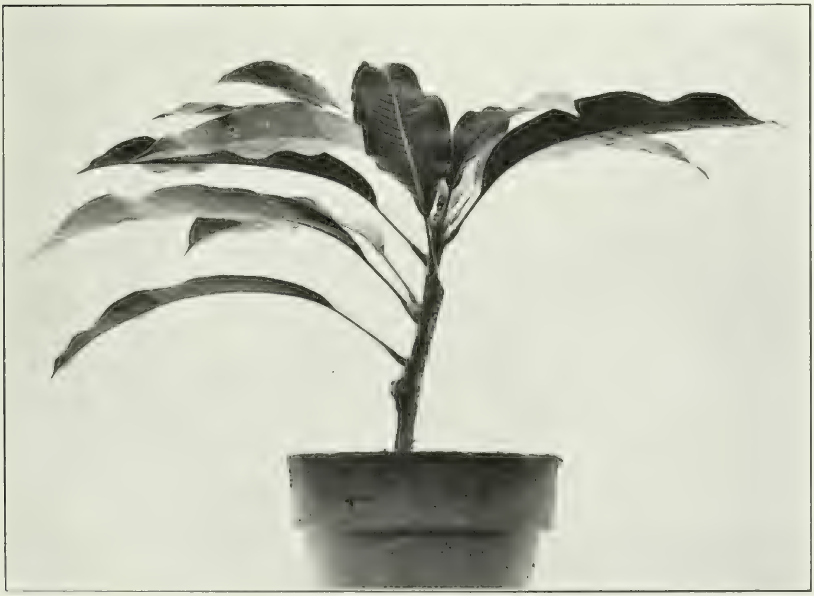


FIG. 2.—NEWLY INARCHED MANGO IN POT.

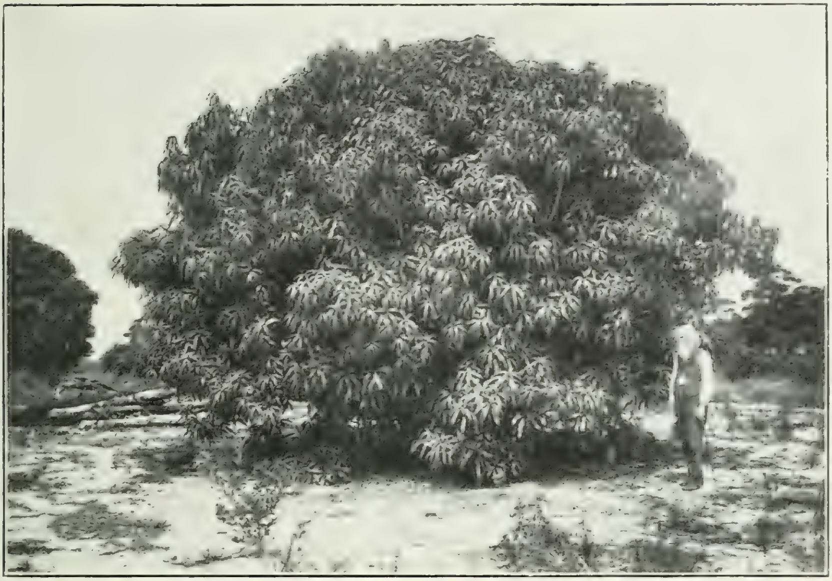


FIG. 1.—MULGOBA MANGO GROWING AT MANGONIA, FLA.

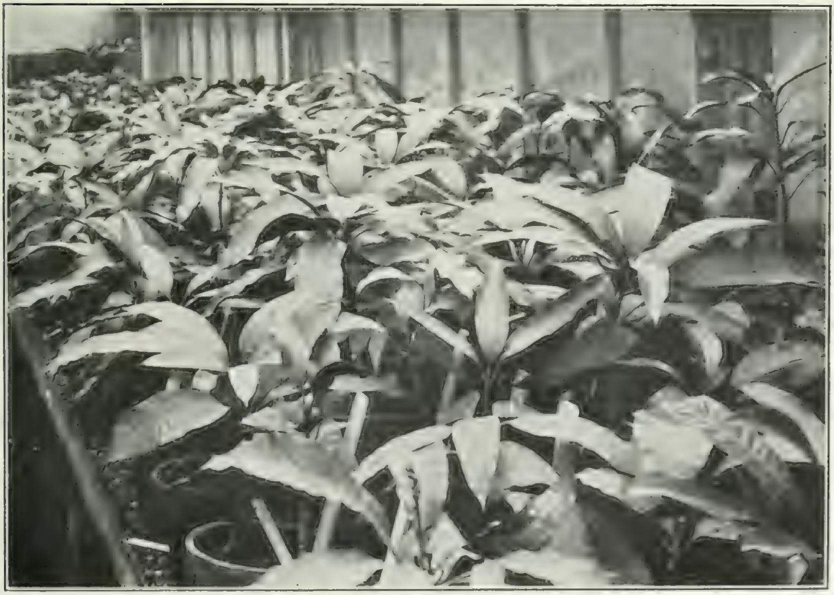


FIG. 2.—BENCH OF NEWLY INARCHED MANGOS.

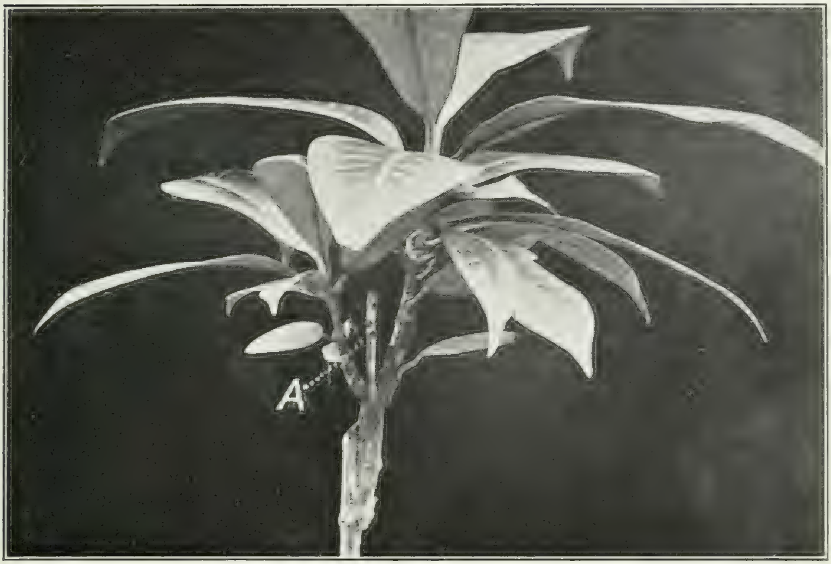


FIG. 1.—SICKLY MANGOSTEEN RESTORED TO HEALTH BY INARCHING.

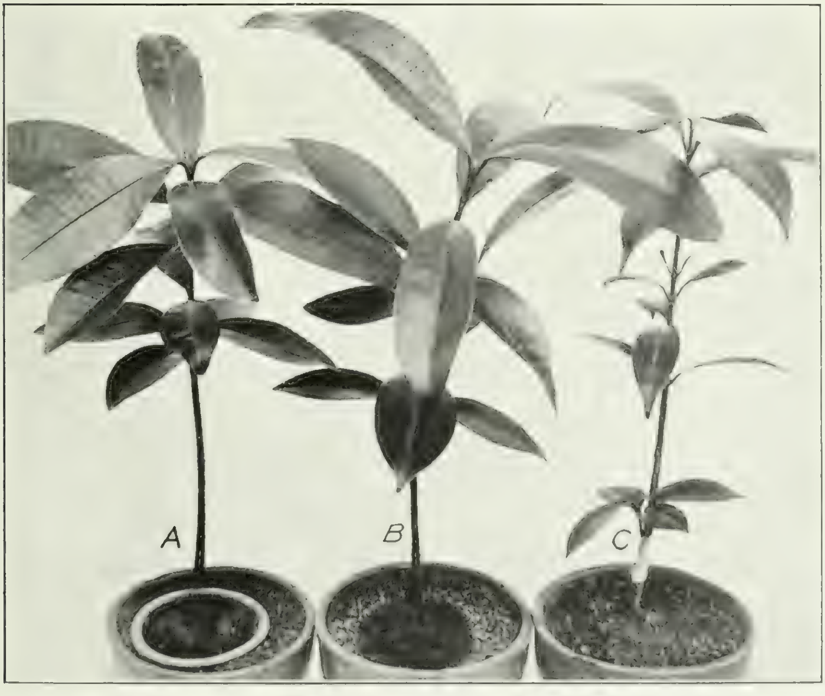
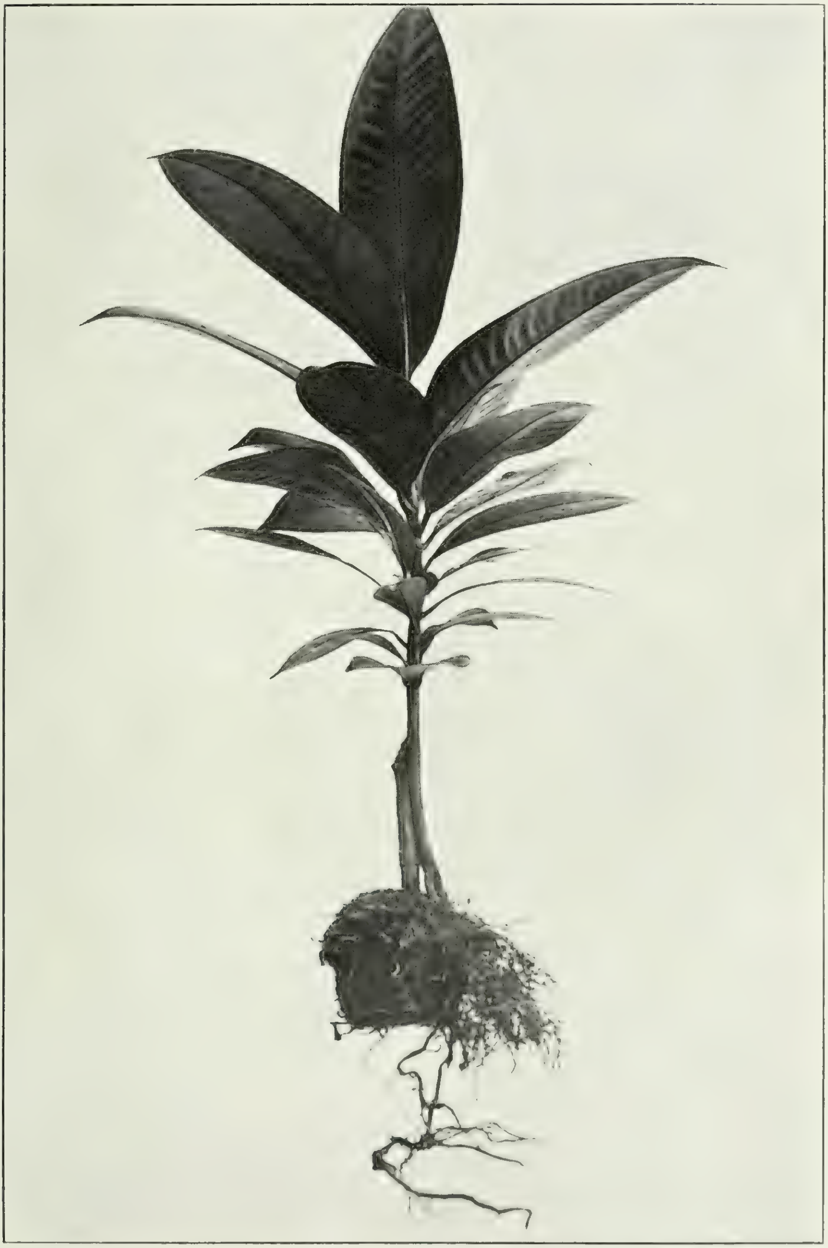


FIG. 2.—INARCHING THE MANGOSTEEN BY THE NURSE-PLANT METHOD.



MANGOSTEEN SEEDLING INARCHED TO GARCINIA TINCTORIA, NURSE PLANT.

(Much reduced.)

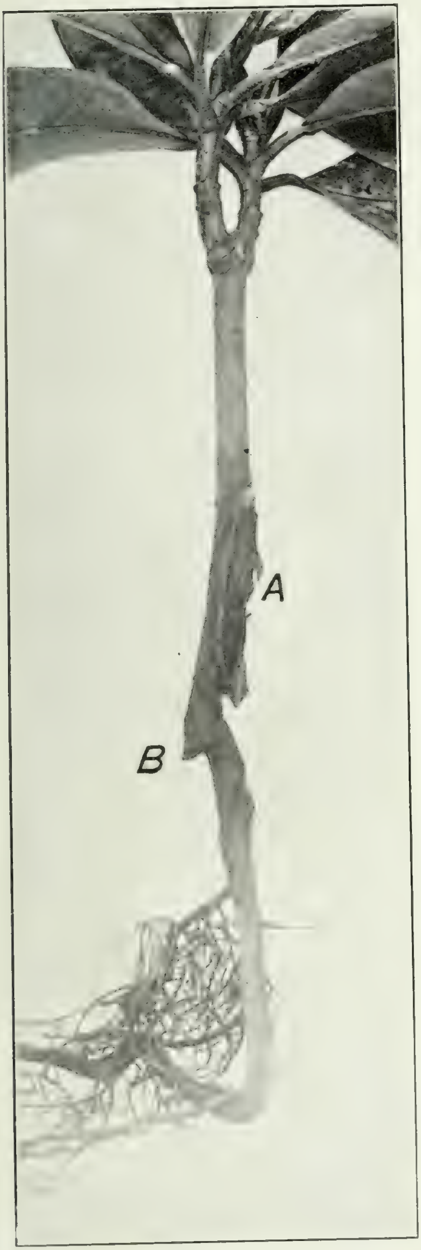


FIG. 1.—INARCHED MANGOSTEEN REESTABLISHING ITS OWN ROOT SYSTEM.

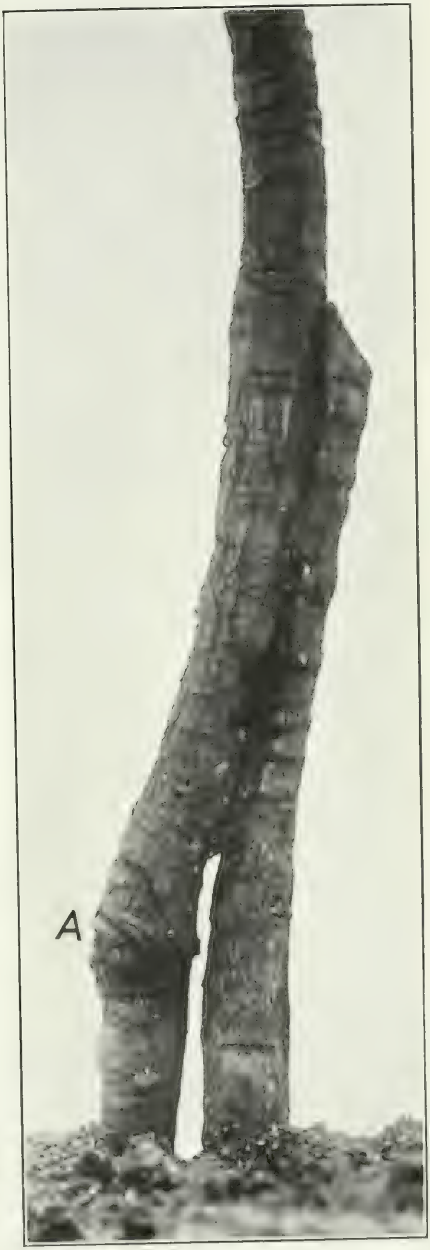
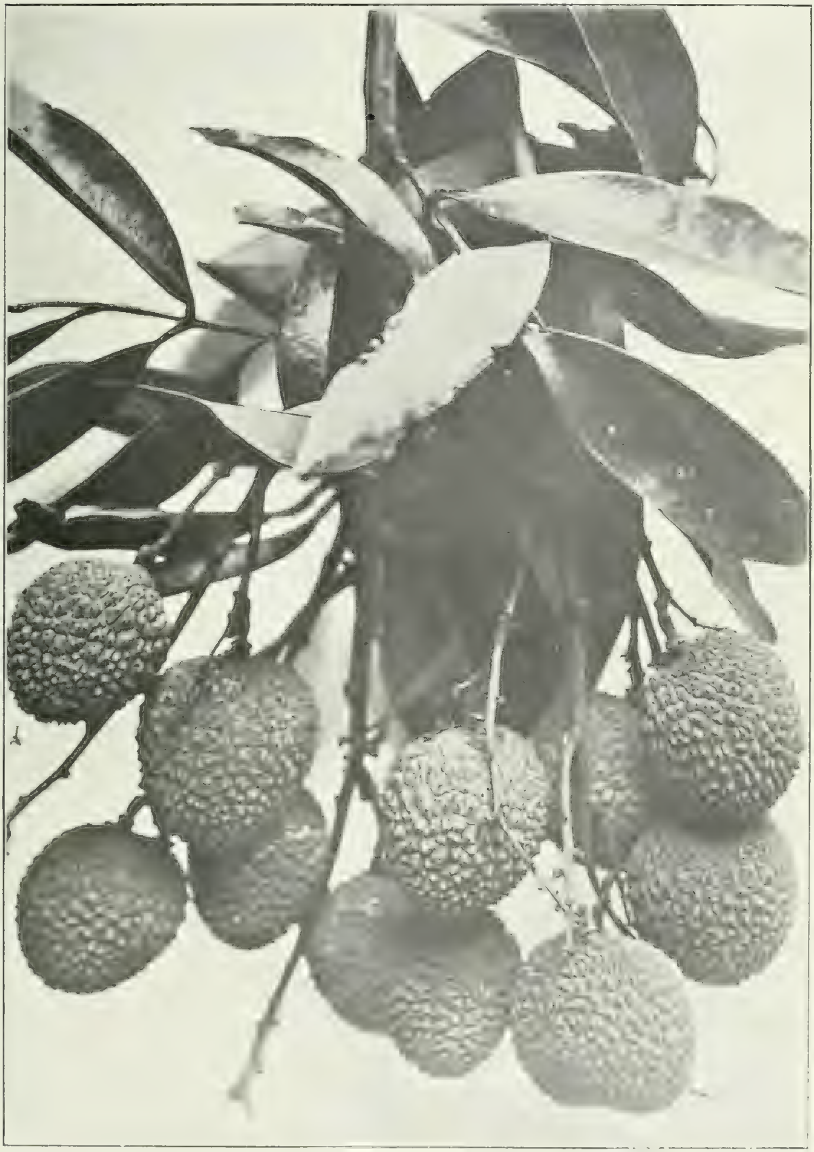


FIG. 2.—MANGOSTEEN DEVELOPING ROOT AFTER INARCHING.



FRUITING BRANCH OF THE LITCHI (LITCHI CHINENSIS).

(Two-thirds natural size.)

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 203.

B. T. GALLOWAY, *Chief of Bureau.*

THE IMPORTANCE AND IMPROVEMENT OF THE GRAIN SORGHUMS.

BY

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Agronomist in Charge of Grain-Sorghum
Investigations.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 21, 1910.

Sir: I have the honor to transmit herewith a paper entitled "The Importance and Improvement of the Grain Sorghums," by Mr. Carleton R. Ball, Agronomist in Charge of Grain-Sorghum Investigations, and recommend its publication as Bulletin No. 203 of the series of this Bureau. This paper presents the best known methods of improving these crops, both at experimental stations and on the farms where they are grown. The value of the grain for feeding stock and poultry is shown, and the acreage, yields, and acre values of these crops are recorded so far as data are available. The facts presented are the result of four years of work in the Office of Grain Investigations.

The areas devoted to grain sorghums in the dry regions of the Southwest are rapidly increasing. Their earliness, productive power, and strong drought resistance especially adapt them to semiarid conditions. The importance of these crops, however, is even greater than can be measured in terms of increased acreage. They are not only staple crops, but in many places they are the chief dependence of the new settler, and their success or failure determines his ability to become established.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE IMPORTANCE AND IMPROVEMENT OF THE GRAIN SORGHUMS.

INTRODUCTION.

The aim of this paper is to show the importance and uses of the grain sorghums and to indicate how they may be further improved. By grain sorghums are meant all the different varieties of the milo, durra, kafir, and kowliang groups of sorghums. These groups are grown primarily for the grain they produce; only the kafirs are grown to any great extent for forage apart from the grain. By improvement is meant changes in methods of handling and in the habits of the plants themselves. These changes must be such as will make them better yielders or otherwise better adapted to the needs of the grower.

In many localities unimproved varieties of grain sorghums are being grown. Most farmers can improve their local varieties. Some of them do so to a very creditable extent, others neglect this entirely. Such work should be much more generally done, and probably would be if the methods of doing it were more commonly understood. In some communities improved varieties have been introduced and are grown by most of the farmers. The work of improving these must be continued by the growers, however, or they are likely to become gradually poorer. This deterioration is caused by mixing with unimproved strains of the same variety or through crossing with other varieties.

Such crossing, or hybridizing, is more common in the sorghums than in most other farm crops. This is because they are all open fertilized; that is, intended to be cross fertilized by means of the wind. The ease with which such crossing occurs is increased because they are most largely grown in regions of fairly constant winds and because their greater height enables the wind to carry the pollen of sorghums farther than that of lower crops.

Before taking up the study of methods of improvement it is desirable to consider the region in which the grain sorghums are grown and to know something of the origin, history, general adaptations, and importance of the crops themselves.

THE GRAIN-SORGHUM BELT.

BOUNDARIES.

The grain sorghums are most largely grown in the southern half of the Great Plains region (fig. 1).

Broadly speaking, this region includes the plain lying between the ninety-eighth meridian of longitude and the Rocky Mountains. The southern half of it may be said to include the area between the northern boundary of Kansas and the Mexican border, although the extreme southern part of western Texas does not belong to the Great Plains proper. The area thus bounded takes in the western half of

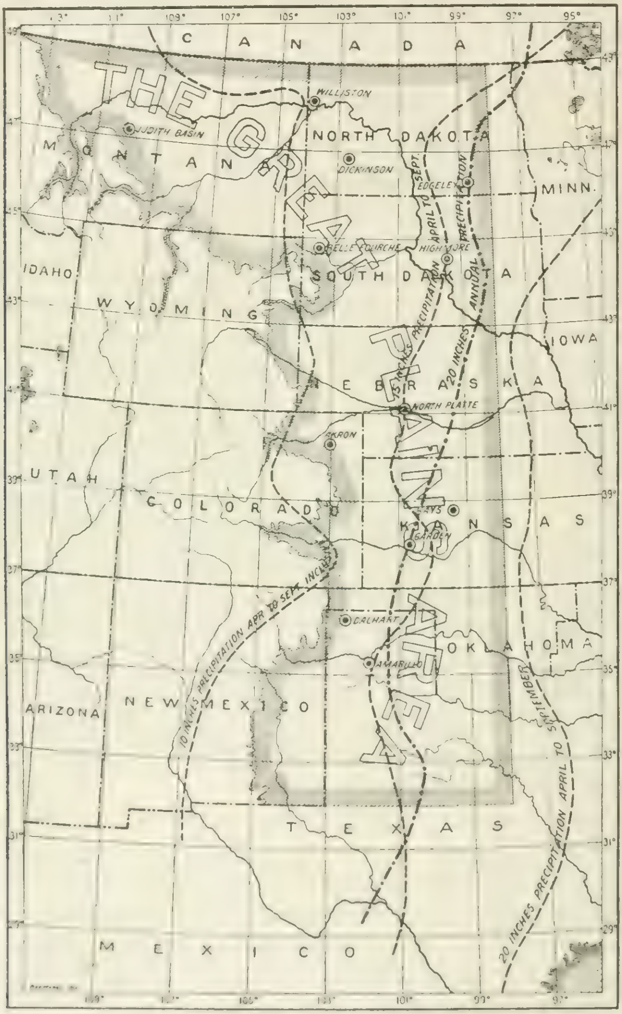
THE GREAT PLAINS AREA
CANADA
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
MINN.
IDAHO
WYOMING
NEBRASKA
IOWA
UTAH
COLORADO
KANSAS
ARIZONA
NEW MEXICO
OKLAHOMA
TEXAS
MEXICO
WILLISTON
JUDITH BASIN
DICKINSON
EDGELEY
BELLE FOURCHE
HIGHMORE
NORTH PLATTE
AKRON
HAYS
GARDEN
DALHART
AMARILLO
APRIL TO SEPT.
ANNUAL PRECIPITATION
20 INCHES
10 INCHES PRECIPITATION APR TO SEPT INCL.
20 INCHES PRECIPITATION APRIL TO SEPTEMBER
109°
107°
105°
103°
99°
95°
49°
47°
45°
43°
41°
39°
37°
35°
33°
31°
29°

Fig. 1.—Map of the Great Plains area, showing the annual and the seasonal rainfall.

Kansas, the western third of Oklahoma, the western half of Texas, and all those portions of Colorado and New Mexico that lie east of the Rocky Mountains. In round numbers the area is 400 miles wide and 1,000 miles long. So important are these crops in this area that it may well be called the "grain-sorghum belt."

SURFACE FEATURES.

The surface of the area just outlined is in general a gently rolling plain, sloping steadily eastward from an elevation of 4,000 to 5,000 feet at the base of the Rocky Mountains to an average elevation of 1,000 to 1,500 feet at the ninety-eighth meridian. The highest point in these plains is not at the base of the mountains, but some distance east of them, in Elbert and El Paso counties, Colorado, where the altitude increases to nearly or quite 6,500 feet. While the main slope is toward the east, there is also a secondary slope to the north and south from this high area in Colorado. Looked at from above the surface of the whole Great Plains region may be compared in outline to half of an inverted saucer, the rim lying toward the east.

SOILS AND PLANT COVERING.

The soils of this region vary from the dark clays of the central Panhandle and the red clays of western Oklahoma, through sandy loams found in various parts of the region to very sandy soils, such as characterize the sand-hill country of Kansas and Colorado.

The plant covering of the loams and clays is mostly a dense sod of buffalo grass and blue grama mixed. In southwest Texas the buffalo grass gives place to the curly mesquite, or running mesquite, as it is often called (*Hilaria cenchroides*). On the more sandy soils taller and more bunchy grasses prevail, such as the bluestems (*Andropogon provincialis, A. scoparius, A. saccharoides*, etc.). In much of western Texas the plains have been largely covered by a more or less dense growth of the mesquite tree (Prosopis). In southern Texas this becomes a large tree, but as it ascends to the higher plains its size diminishes until in the upper Panhandle it is only a low shrub or bush.

CLIMATE.

What really separates the so-called Great Plains region from the country lying immediately east of it is, primarily, not differences in either elevation or soil, but the lower rainfall and higher evaporation of moisture. The average annual rainfall for the grain-sorghum belt, as defined above, is about 20 inches, of which more than half comes in the months of April to September, inclusive. (See fig. 1.) The summer temperature is fairly high, and this, with the steady breeze which prevails over much of this area, makes evaporation rapid and continuous.

All crops to be suitable for use in this area must have the ability either to withstand or to escape drought in one way or another. Dry, hot winds occasionally occur in some parts of the region, often quickly and completely destroying all tender vegetation. At the higher elevations and in the northern part generally the season is comparatively short and early varieties must be used, because late spring frosts occur and the first frosts of autumn come rather early.

AGRICULTURAL DEVELOPMENT.

The process of dividing the great cattle ranges and selling them for farms is going on steadily. Wherever government land remains homesteads are being taken up. In the past few years the settlement of this dry country has been rapid. Rapid settlement may be desirable; it is much more important, however, that it be permanent. This has not always been the case.

No one may say with certainty just what the future of this southern Great Plains region is to be. It gives promise of becoming a second great feeding belt, similar to the corn belt. Nothing better could be wished than that it should grow live stock and the crops to feed them. Under such a system of farming this area would produce much more live stock than it ever did or could under the ranch and range system. If it should raise a money crop in addition, so much the better. This might be cotton in the southern part, winter wheat in the central, and spring wheat in the northern part, with broom corn and other minor crops in different parts. The area is admirably adapted to the growing of both the stock and the necessary feeding crops. These crops will be corn in the regions of lower altitude and greater rainfall and grain sorghums in the higher and drier parts.

IMPORTANCE OF THE GRAIN-SORGHUM CROP.

The following paragraphs cover briefly the history of the grain sorghums in the United States, the general conditions to which they are adapted, and some statistics of their acreage, yield, and value.

HISTORY OF THE VARIETIES.

It is only thirty-five years since the first grain sorghums (fig. 2) were introduced into the United States. It is only twenty years since any of them have become crops of recognized importance. Although grain-producing varieties had probably been introduced from time to time since early colonial days none had persisted in cultivation.

The first permanent introductions were the two durras, Brown durra and White durra, which reached California in 1874 under the names, "Brown Egyptian corn" and "White Egyptian corn." The white variety had two periods of popularity in the Great Plains area, first, in the early eighties, under the name "Rice corn," and again, ten years later, under the name "Jerusalem corn." Both varieties are still grown, but only to a limited extent owing to their shattering habit.

Two varieties of kafir, the White and the Red, were brought from South Africa in 1876. They did not get into general cultivation here until about 1890, fourteen years later. The Blackhull kafir appeared soon after, but whether it was a part of the original importation or was a later introduction will probably never be known. The original White kafir is rarely found in cultivation to-day, but the Red and the Blackhull are important crops.

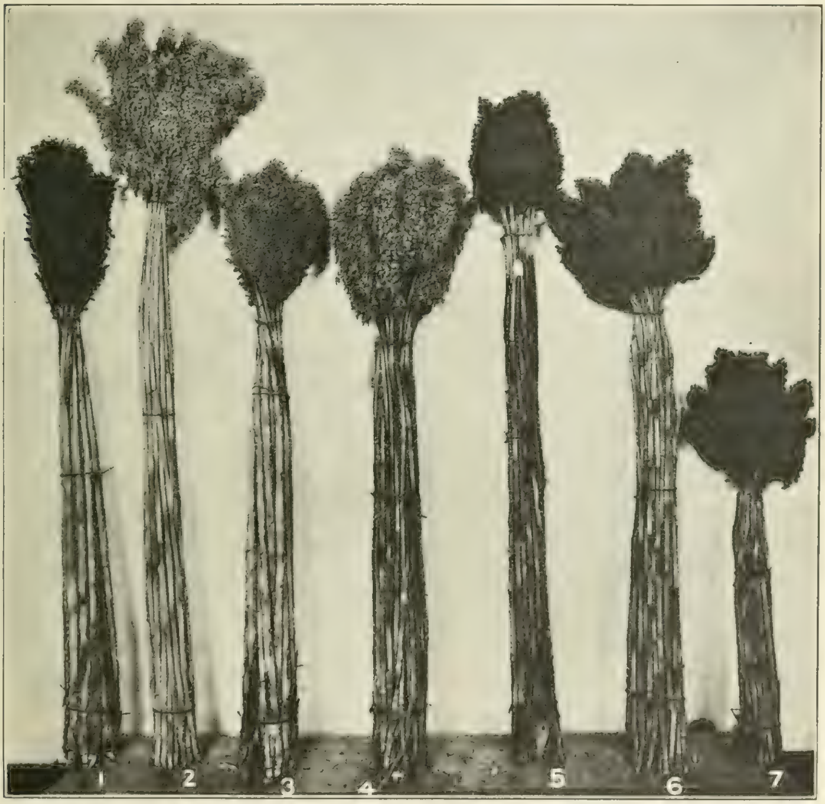

FIG. 2.—Sheaves of improved grain sorghums: 1, Red kafir; 2, shallu; 3, Blackhull kafir; 4, White durra; 5, Brown kowliang; 6, milo; 7, Dwarf milo.

Milo was first introduced into South Carolina or Georgia about the year 1885, but did not come into general notice until about 1890, when it had become a staple crop in parts of western Texas.

The kowliangs have been coming from China and Manchuria since 1901. Most of them have required considerable selection to make them suitable for use as grain crops. None of them has been long enough in the hands of farmers to be considered a farm crop.

In the brief space of twenty years, however, the milos and kafirs have greatly increased in importance. They are now grown as staple farm crops on a large scale over a considerable area of the West.

ADAPTATIONS TO THE GRAIN-SORGHUM BELT.

It is in the western region previously described that the grain sorghums prove themselves most completely at home. They are here not only staple crops, but they are often the chief dependence of the new settler, because they may be grown as sod crops. By homesteaders with small means and limited equipment, they can be cheaply planted on breaking. They are often planted, cultivated, harvested, and even thrashed by hand under such circumstances.

When these crops were first introduced they were tried in various parts of the United States. One after another they were found unsuited to the conditions in most of the country and were discarded. But out on the Great Plains they grew in favor with the farmer because they were able to stand the prevailing conditions. They are able to grow and make profitable yields in hotter, drier climates than most crops. Some of them are early enough for use at comparatively high elevations. They are all cultivated crops, entering readily into the rotation with small grains. They furnish the feeding grain required on the farm, also some roughness, and occasionally both fuel and food in addition. The surplus can always be sold at fair to good prices. When grown on a large scale they are handled rapidly and profitably by machinery in every necessary operation from seeding to milling. They are undoubtedly suited to become the basis of a cattle-feeding industry that will make the Great Plains farmer prosperous.

USES OF THE GRAIN.

STOCK FEED.

Primarily these grains are and ought to be useful in feeding stock on the farms where they are grown. This fact accords with the history of these crops and is due to their adaptations for such use. They were the principal crops of the early settler in the dry-land areas of the southern Great Plains region. He not only needed a feeding grain but was often too far from market to sell it profitably if he had wished.

The value of the grain for keeping work stock, growing animals, and dairy cows in excellent condition has long been recognized among the growers. The knowledge of its value in fattening cattle and hogs for market is increasing. A number of experiments to determine the feeding value have been conducted at the agricultural experiment stations of Kansas,[a] Oklahoma,[b] and Texas.[c] In many of these trials the Blackhull-kafir grain, which was most generally used, was shown to have a feeding value little below that of corn.

Table I shows the average chemical composition of a large number of samples of grain sorghums. In order to show the range of variation in composition, the minimum and maximum percentages found are given also. The analyses of the grain sorghums were made by Dr. J. S. Chamberlain, of the Bureau of Chemistry, in cooperation with the Office of Grain Investigations of the Bureau of Plant Industry. For comparison, the minimum, maximum, and average percentages found in 208 analyses of corn kernels are reprinted from Bulletin 11 of the Office of Experiment Stations.

The average analyses of all the grain-sorghum samples and all the corn samples are fairly comparable. The 49 grain-sorghum samples were grown in 1905, 1906, and 1907, mostly in the Great Plains area. The 208 corn samples were grown in many different States and years. The average composition of 10 grain-sorghum samples and of 12 corn samples grown at different times and places, determined by Doctor Chamberlain, and reprinted from Bulletin 120 of the Bureau of Chemistry, is also included in the table. From these figures and from others based on fewer analyses, but covering both crops grown under similar conditions, it is known that they are not very different in composition. In general, the grain-sorghum kernels average a little higher than corn in protein content and a little lower in ether extract, or fat, and in fiber. The range of variation in the protein content, from 7.93 to 16.63 per cent, indicates that high-protein varieties and strains can probably be readily developed by selecting for this quality.

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[a] Bulletin 56, Kansas Agricultural Experiment Station.

[b] Bulletins 35, 37, and 46, Oklahoma Agricultural Experiment Station.

[c] Bulletins 95, 97, 104, and 110, Texas Agricultural Experiment Station; also an unnumbered circular of the Texas Agricultural Experiment Station entitled "Panhandle Feeds for Beef Production."

TABLE I.—*Composition of grain-sorghum kernels and corn kernels.*

Crop and percentage.	Number of analyses.	Water.	Water-free substance.				
			Ash.	Crude protein (N×6.25).	Fiber.	Carbohydrates.	Ether extract.
Milo:							
Minimum		9.82	1.57	10.34	1.73	78.91	2.80
Maximum		11.08	1.95	14.34	2.11	82.67	3.31
Average	8	10.61	1.77	12.41	1.86	80.87	3.09
Dwarf milo:							
Minimum		10.18	1.80	11.35	1.68	79.75	2.89
Maximum		10.52	2.06	12.84	2.66	81.92	3.51
Average	4	10.34	1.93	12.08	2.02	80.73	3.24
White durra:							
Minimum		9.70	1.93	7.93	1.49	78.33	3.34
Maximum		10.16	2.43	12.39	2.32	84.90	4.31
Average	5	9.87	2.17	11.22	1.85	80.81	3.95
Blackhull kafir:							
Minimum		9.87	1.80	9.93	1.84	76.88	3.08
Maximum		10.16	1.97	15.64	2.39	82.12	3.79
Average	5	10.05	1.90	13.69	2.08	78.87	3.46
Red kafir:							
Minimum		10.16	1.60	12.04	1.68	78.11	2.46
Maximum		10.55	2.05	14.47	2.91	81.26	3.48
Average	3	10.31	1.78	13.01	2.14	79.95	3.12
Brown kowliang:							
Minimum		9.75	1.76	8.80	1.46	79.13	4.37
Maximum		10.86	2.26	12.13	2.59	82.83	4.95
Average	7	10.26	2.12	10.51	1.75	80.98	4.64
Blackhull kowliang	1	9.99	1.96	11.52	1.63	80.18	4.71
White kowliang	1	10.05	2.40	11.53	1.39	79.53	5.15
Shallu:							
Minimum		9.37	1.42	13.01	1.73	76.42	2.57
Maximum		10.06	2.12	15.24	1.96	80.87	4.33
Average	3	9.70	1.76	13.88	1.85	78.78	3.72
Grain sorghums:							
Minimum		9.37	1.36	7.93	1.39	76.42	2.46
Maximum		11.08	2.43	16.63	2.91	84.90	5.15
Average	49	10.22	1.93	12.23	1.92	80.06	3.86
Average of other samples[a]	10	11.71	1.75	11.71	1.80	81.58	3.25
Corn grown in many States and different years:							
Minimum		4.50	1.10	7.70	.80	67.20	3.80
Maximum		20.70	3.10	17.00	5.70	84.80	12.80
Average	[b] 208	10.89	1.70	11.70	2.40	78.10	6.10
Average of other samples[a]	12	13.06	1.52	9.91	2.21	81.96	4.40

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[a] Chamberlain, J. S. The Feeding Value of Cereals, as Calculated from Chemical Analyses, Bulletin 120, Bureau of Chemistry, U. S. Dept. of Agriculture, 1909, p. 42.

[b] Jenkins, E. H., and Winton, A. L. A Compilation of Analyses of American Feeding Stuffs, Bulletin 11, Office of Experiment Stations, U. S. Dept. of Agriculture, 1892, pp. 16–17.

Table II gives some analyses, on the air-dry basis, made by the Texas Agricultural Experiment Station and published in Bulletin 95 of that station. Chops are composed of thrashed grain, more or less finely chopped or crushed. Head chops are made by chopping the unthrashed heads, and are therefore similar to and comparable with the corn-and-cob meal. The high fiber content of these last-named products is due, of course, to the woody panicle branches and cobs. The fiber content of thrashed seed, free from the glumes, seldom runs higher than 2 or 2.5 per cent.

TABLE II.—*Composition of chops, head chops, and corn-and-cob meal.*

Crop and product.	Number of analyses.	Air-dry substance.					
		Water.	Ash.	Crude protein (N×6.25).	Fiber.	Carbohydrates.	Ether extract.
Milo chops	14	9.66	2.30	10.73	3.05	72.22	2.78
Kafir chops	19	9.86	1.63	10.98	2.75	71.18	3.12
Corn chops	9	11.81	1.19	9.60	2.52	71.71	3.90
	475	....	....	9.30	....	....	4.10
Milo head chops	4	9.42	2.71	9.22	6.51	69.55	2.44
Kafir head chops	3	13.62	2.82	9.25	8.03	63.38	2.62
Corn-and-cob meal	10	10.01	1.28	10.14	7.10	68.78	3.69
	10	....	2.01	8.51	7.98	....	3.49

Many grain elevators in the Great Plains region have been equipped with machinery for thrashing and grinding these grains. The grain should be cracked or ground before feeding to get the best results. In the form of milo chops and kafir chops, it is becoming a popular commercial article. Head chops are not meeting with as much favor because of the included "dirt," composed of the glumes, glume hairs, awns, etc. It is for this reason that the elevators have installed thrashing machinery.

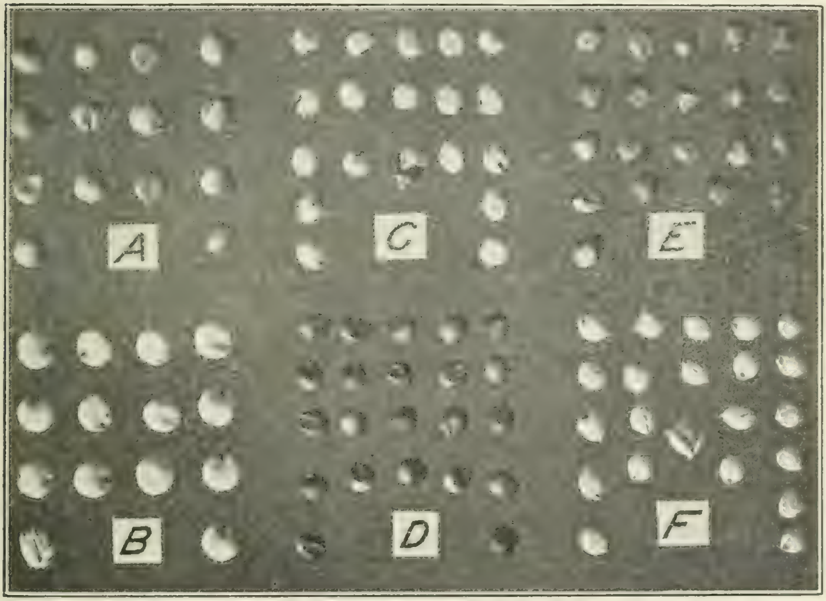

FIG. 3.--Seeds of grain sorghums: *A*, Milo; *B*, White durra; *C*, Blackhull kafir; *D*, Red kafir; *E*, Brown kowliang; *F*, shallu. (Natural size.)

POULTRY FEED.

The grain-sorghum seeds (fig. 3) are splendidly adapted, both in size and composition, for feeding to all classes of poultry. In many parts of the country, outside the grain-sorghum belt, small patches of kafir, durra, or other "chicken corn" are commonly grown on the farm simply to furnish chicken feed.

In 1908 inquiries were addressed to 114 firms manufacturing over 200 brands of poultry food. Data received from 33 firms show an annual output of about 30,000 tons of these products. Of this total quantity about 10,000 tons, or one-third of the total, consisted of Blackhull kafir seed. This was mostly used in mixtures with other grains, as corn, wheat, etc. From these facts it is probably safe to conclude that kafir or other grain-sorghum seed forms at least 25 per cent of the prepared poultry food sold in this country. So strong is the demand for these grains by poultry-food manufacturers that similar varieties have been imported from as far away as India when the crop in this country was short. Such importations are being made at the date of writing.

HUMAN FOOD.

Meal made from the grain sorghums ground locally is not infrequently used in the making of batter cakes and similar articles of food on the farm. The general testimony is that these are delicious in quality. Some experiments are now being conducted in a small way to determine the value of the meal for more extended use. There seems little reason why, when properly milled, it should not be used in much the same manner as corn meal. Throughout Africa, India, and the other parts of southern and eastern Asia, where these crops are largely grown, they are not only commonly used as human food, but in many countries they furnish the chief article of diet.

STATISTICS OF ACREAGE, YIELD, AND VALUE.

SCOPE OF DATA.

Complete statistics of the production of grain-sorghum crops are not available. The national census, taken every ten years, has not yet separated them in its schedules from other related crops. Of the five or six States which grow them largely, only two—Kansas and Oklahoma—gather state statistics of farm crops. The figures have been gathered in Kansas since 1893, but in Oklahoma only since 1904 for kafir and since 1905 for milo.

TOTAL GRAIN-SORGHUM CROPS IN KANSAS AND OKLAHOMA.

Table III shows the acreage, yield, and value of grain sorghums grown in Kansas and Oklahoma for a series of years. These results have been compiled and adapted from the figures given in the reports of the State Board of Agriculture for each of the two States.

In the Kansas figures three groups of grain sorghums are included, namely, kafirs, milos, and White durra ("Jerusalem corn"). Since the area devoted to the White durra has not been larger than 4,000 acres but once in the last fifteen years, it may be neglected and the figures regarded as representing only kafirs and milos—the two staple crops. The yield for Kansas is shown in tons of fodder per acre, instead of bushels of grain.

In the figures for Oklahoma two groups of grain sorghums are included, namely, kafirs and milos, except for the first year, 1904, in which no returns were obtained for milo, and the figures given are for kafir only. For the years 1904 to 1906, inclusive, the returns are from only the former Territory of Oklahoma. For 1907 and 1908 they are from the entire new State, including the former Indian Territory. This probably accounts for the apparent sudden increase in acreage of 1907 over 1906.

The yield for Oklahoma is shown in bushels of grain per acre. The value of the crops is computed from the value of the grain alone for all the years except 1908. In that year returns were also made for the tonnage and value of the stalks. The value of the stalks has therefore been added to the value of the grain for that year to make the total value of the crops, from which the acre value is computed. The value of kafir stalks was found to be nearly one-half as much as the value of the kafir grain, or nearly one-third the combined value of both. The stalk value of milo was exactly one-fourth the grain value, or one-fifth of the combined value. It is not clear from the Oklahoma reports whether the fodder and grain represent the product of the same fields or whether the figures for fodder are intended to cover fields not used for grain. It is here assumed that the former was intended.

TABLE III.—*Acreage, yield, and value of total grain-sorghum crops for certain years in Kansas and Oklahoma.*

Year.	Kansas.					Oklahoma.				
	Acreage.	Yield in tons.		Value.		Acreage.	Yield in bushels.		Value.	
		Total.	Per acre.	Total.	Per acre.		Total.	Per acre.	Total.	Per acre.
1893	77,942	190,489	2.44	$553,320	$7.10	....	....	....	....	....
1895	231,498	793,154	3.43	2,079,285	8.98	....	....	....	....	....
1900	652,667	1,985,940	3.04	5,814,389	8.91	....	....	....	....	....
1904	528,142	1,609,038	3.05	5,136,412	9.72	334,948	3,280,510	9.79	$1,312,204	$3.92
1905	575,038	1,862,799	3.24	5,726,978	9.96	435,894	6,562,298	15.05	2,624,920	6.01
1906	569,701	1,727,965	3.03	5,216,985	9.16	391,565	6,513,926	16.63	2,336,704	5.97
1907	533,007	1,561,943	2.93	5,919,197	11.10	502,771	6,757,197	13.44	4,023,130	8.00
1908	688,582	1,908,551	2.77	7,407,516	10.76	545,143	5,529,219	10.14	3,305,765	6.06
1909	741,983	1,987,258	2.67	8,145,508	10.98	....	....	....	....	....
Average for years since 1904, inclusive	....	....	2.95	....	10.28	....	....	13.01	....	5.99

It will be noted that the total area devoted to grain-sorghum crops in Kansas was larger in 1900 than in 1905. The maximum acreage was reached in 1902, with a total of 757,000 acres. After 1902, the acreage decreased slowly until 1907, and then began a steady increase. It may be noted that in 1907, the year of lowest acreage, the highest value per acre resulted. In Oklahoma there has been a fairly constant increase in acreage during the years covered by the statistics. In both States there has been a general rise in the acre value of these crops. The figures do not indicate, however, that yields per acre are increasing.

KAFIR, MILO, AND CORN CROPS IN KANSAS AND OKLAHOMA.

Table IV shows the annual production of kafir, milo, and corn in Kansas and Oklahoma for the years since 1904, inclusive.

The proportion of grain sorghums to corn grown in these States is steadily increasing with the settlement of the drier western portions. The average acreage of grain sorghums for the period 1904 to 1909 in Kansas was equal to 8.7 per cent of the average corn acreage. For the year 1909 alone it had increased to 9.6 per cent in spite of an enormous increase in the corn acreage. In Oklahoma the same figures are not comparable because of the change from a small Territory to a larger State, but the average grain-sorghum acreage in the old Territory from 1904 to 1906 was equal to 25.6 per cent of the corn area. In 1907, in the new State, including both Oklahoma and Indian Territories, it was 12.5 per cent, and in 1908 12.7 per cent. The apparent decrease in the second period is due to the fact that Indian Territory grew much corn and little grain sorghum.

As pointed out before, the grain sorghums are all grown most extensively in the drier areas west of the ninety-eighth meridian. In Kansas about 45 per cent of the kafir and about 95 per cent of the milo is found west of this line, which divides the State almost exactly in half. In Oklahoma about one-third of the State lies west of this line and contains 79 per cent of the kafir and 98 per cent of the milo.

TABLE IV.—*Acreage, value, and yield of kafir, milo, and corn for the years 1904 to 1909, inclusive, in Kansas and Oklahoma.*

Crop and year.	Kansas.					Oklahoma.				
	Acreage.	Yield per acre in tons or bushels.	Value.			Acreage.	Yield per acre.	Value.		
			Per ton or bushel.	Total.	Per acre.			Per bushel.	Total.	Per acre.
Kafir:		*Tons.*	*Per ton.*				*Bush.*			
1904	518,372	3.04	$3.19	$5,041,546	$9.70	334,948	9.79	$0.40	$1,312,204	$3.92
1905	538,393	3.24	3.06	5,352,810	9.91	297,286	12.72	.40	1,512,318	5.08
1906	548,497	3.05	3.01	5,039,238	9.18	269,218	16.10	.34	1,465,937	5.44
1907	508,485	2.94	3.78	5,658,860	11.11	371,405	13.50	.58	2,881,032	7.77
1908	630,096	2.85	3.82	6,856,845	10.89	400,047	9.20	.46	[a]2,548,200	6.36
1909	636,201	2.79	4.02	7,150,080	11.21	...	...	...	...	...
Average	...	2.99	3.48	...	10.33	...	12.26	.44	...	5.71
Milo:										
1904	7,166	3.18	3.22	73,476	10.24	...	...	...	...	...
1905	20,550	2.84	3.28	190,974	9.31	138,608	20.06	.40	1,112,602	8.02
1906	17,563	2.55	3.26	146,289	8.31	122,347	17.82	.40	870,767	7.12
1907	22,090	2.72	3.90	234,686	10.61	131,366	13.30	.65	1,142,098	8.64
1908	55,255	1.92	4.85	515,269	9.31	145,096	12.55	.33	[b]757,565	5.22
1909	102,492	1.97	4.74	959,259	9.34	...	...	...	...	...
Average	...	2.53	3.87	...	9.52	...	15.93	.45	...	7.25
Corn:		*Bushels.*	*Per bushel.*							
1904	6,494,158	20.3	.39	50,713,955	7.81	1,369,276	16.00	.39	8,544,339	6.24
1905	6,799,755	28.0	.36	68,718,584	10.11	1,642,930	18.90	.40	12,436,557	7.56
1906	6,584,535	28.4	.35	65,115,203	9.25	1,528,735	31.40	.36	17,142,081	11.21
1907	6,809,012	21.3	.43	63,040,743	9.26	4,014,631	18.10	.48	35,409,961	8.82
1908	7,057,535	21.3	.55	82,642,462	11.71	4,284,561	18.60	.48	38,449,866	8.97
1909	7,711,879	19.1	.57	83,066,905	10.77	...	...	...	...	...
Average	...	23.1	.44	...	9.83	...	20.60	.42	...	8.56

[a] Includes $828,131 worth of fodder.

[b] Includes $151,911 worth of fodder.

The 46 counties in the western half of Kansas grew, in round numbers, 240,000 acres of grain sorghums in 1907, 334,000 acres in 1908, and 396,000 acres in 1909. This was an increase of 39 per cent in the grain-sorghum acreage for 1908 and of 18.6 per cent for 1909. The same counties grew 1,500,000 acres of corn in 1907, 1,750,000 acres in 1908, and 2,000,000 acres in 1909, increases of 17 and 14 per cent, respectively. The ratio of the acreage of grain sorghums to that of corn was 1 to 6.2 in 1907, 1 to 5.3 in 1908, and 1 to 5.1 in 1909. The grain-sorghum acreage was therefore equal to 16.1 per cent, 18.9 per cent, and 19.5 per cent of the corn acreage of these three years, respectively. Ten of these counties grow larger areas of grain sorghum than of corn.

The 21 counties now comprising the western third of Oklahoma grew 327,000 acres of grain sorghum in 1906, 423,000 acres in 1907 (29 per cent increase), and 465,000 acres in 1908 (10 per cent increase). The ratio of grain-sorghum acreage to that of corn was 1 to 2.1 in 1906, 1 to 2.7 in 1907, and 1 to 3.1 in 1908. These ratios represent grain-sorghum acreages equal to 47.6 per cent, 37 per cent, and 32.2

per cent of the corn acreages for the same years. Four of these counties grow more grain sorghums than corn.

SUMMARY OF THE VALUES OF GRAIN SORGHUM AND CORN IN KANSAS AND OKLAHOMA.

In Table V is given the minimum, maximum, and average value per acre of grain-sorghum and corn crops in Kansas and Oklahoma. The figures are a summary of the values given in Tables III and IV. It will be noted that for Kansas the minimum acre value of the combined grain sorghums is not as low as the minimum for corn, that the maximum is nearly as high, and that the average acre value is higher by 45 cents an acre. In Oklahoma the relative positions of the crops are reversed.

Two facts must be kept in mind while comparing these figures. One is that for Kansas the yields and values of grain sorghums are based on tons per acre, and thus include the value of both grain and stover. The yields and values of corn, on the contrary, are based on bushels of grain per acre. If the value of the corn stover were also included, the average acre value for corn would probably somewhat exceed that of the grain sorghums. The difference, however, would probably not be as large as the Oklahoma figures show. The other fact is that the grain sorghums are most largely grown in the western parts of these States. Here the shorter seasons and lower rainfall tend to decrease the yields of all crops. This puts the sorghums at a disadvantage in a comparison with corn, which is most extensively grown in the lower and more humid portions.

TABLE V.—*Summary of values of grain sorghums and corn in Kansas and Oklahoma.*

State and crop.	Number of years.	Yield per acre.	Price per ton or bushel.	Acre value.				
				Minimum.		Maximum.		Average.
				Year.	Value.	Year.	Value.	
Kansas:		*Tons.*	*Per ton.*					
Kafir	6	2.99	$3.48	1906	$9.18	1909	$11.21	$10.33
Milo	6	2.53	3.87	1906	8.31	1907	10.61	9.52
Total grain sorghums	6	2.95	3.48	1906	9.16	1907	11.10	10.28
		Bushels.	*Per bu.*					
Corn	6	33.10	0.44	1904	7.81	1908	11.71	9.83
Oklahoma:								
Kafir	5	12.26	.44	1904	3.92	1907	7.77	5.71
Milo	4	15.93	.45	1908	5.22	1907	8.64	7.25
Total grain sorghums	5	13.01	.44	1904	3.92	1907	8.00	5.99
Corn	5	20.60	.42	1904	6.24	1906	11.21	8.56

IMPROVING THE GRAIN SORGHUMS.

There are two general ways by which grain-sorghum crops can be made of greater value to the grower. First, by improving the varieties; second, by devising more rapid and economical methods of harvesting. Improved varieties can be secured through selection of present sorts (fig. 4), and by bettering the methods of planting them. More rapid and economical harvesting will come about either through adapting the crops to present machinery or through the invention of new machines, or both.

It is better to keep in view the results sought rather than the means by which these results are to be attained. The problems of improvement will therefore be discussed under headings showing the most important results desired. These problems are five in number, namely, (1) increased drought resistance, (2) increased earliness, (3) dwarfness (or diminished stature), (4) greater productiveness, and (5) adaptability to machine handling.

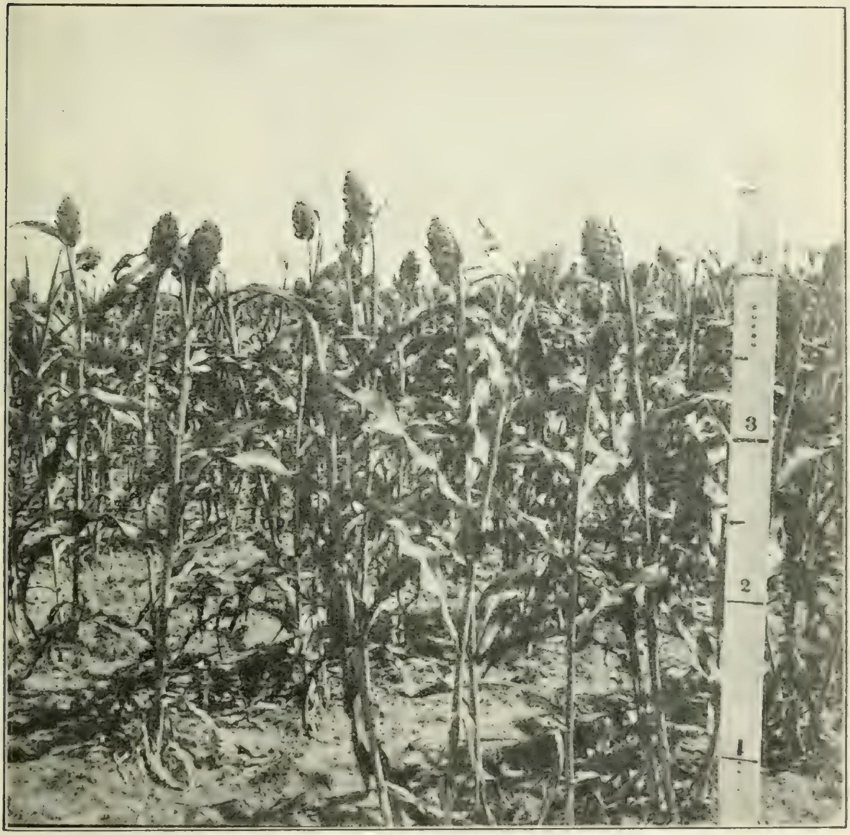

FIG. 4.—Plat of milo, selected for erect heads and low stature.

DROUGHT RESISTANCE.

The grain sorghums find their greatest usefulness in regions where moisture is often the controlling factor in crop production. Much good should therefore be accomplished by increasing their drought resistance, especially in the areas of lighter rainfall.

No one knows exactly what drought resistance is. It is probable that the character called drought resistance is one of several different factors or the result of a combination of two or more of them. The most important of these factors are probably (1) increased ability to prevent the loss of water by transpiration, (2) increased development of the root system, and (3) a possible increase in power to extract water from a dry soil.

Differences in the power to control transpiration are well-known and readily observed facts. In cacti, for instance, this ability is highly perfected. Corn is in danger when the leaves begin to curl, but sorghums often remain in this condition for a long time without permanent injury.

The size and character of the root system are probably a strong factor in drought resistance. The larger the root system in proportion to the plant, the better it can supply moisture. The wider and deeper its penetration, the larger the area of soil from which it draws moisture in time of drought. A deeply rooting plant may be able to secure water when shallow root systems lie wholly in dry soil. This is entirely apart from possible differences in ability to extract moisture from a given unit of soil. Such differences may exist, but the idea is yet only a theory. Unfortunately, the character of the root system can not be observed while making selections.

Selections for drought resistance will usually be made on observed phenomena. These are likely to be the result of a combination of adaptations for actual drought resistance and adaptations for drought evasion. Dwarfness, earliness, and thin stands are adaptations or conditions for drought evasion. Making allowance for these when present, one can select for actual drought resistance. This will be done by using those plants which give best results under dry conditions when they are neither dwarfer, nor earlier, nor more thinly planted than their neighbors.

EARLINESS.

ADVANTAGES TO BE GAINED.

The two principal reasons for desiring early varieties are, first, to extend the range of grain sorghums into dry regions having a short growing season; and, second, to obtain the fullest possible benefit from the seasonal rainfall, which comes largely during the early summer months in parts of the grain-sorghum belt. This second reason is thus connected with the problem of drought resistance, though, as pointed out, earliness is a means of drought evasion, not of resistance.

Improvement in earliness will need to be continued for a long time if varieties are to be perfected for the needs of all the dry-farming regions.

EARLY VARIETIES.

The milos (figs. 4 and 8) are much earlier varieties than the kafirs, and are very promising material on which to work. In the Panhandle of Texas, at elevations of 3,000 to 4,000 feet, they now mature in ninety to one hundred days when sown May 15 to 20. At present they are grown successfully at altitudes between 4,000 and 5,000 feet in Texas, New Mexico, and Colorado. At higher elevations the growing season is shortened to such an extent that the present varieties of milo do not mature. At lower elevations their present range extends northward into southwestern Nebraska. In northern Nebraska, the Dakotas, Montana, and Idaho the increasing latitude and shorter growing season prevent their successful maturing. It seems certain, also, that the soil, especially at night, is too cool to permit vigorous growth, thus retarding the maturing of the plant even where the season is otherwise long enough.

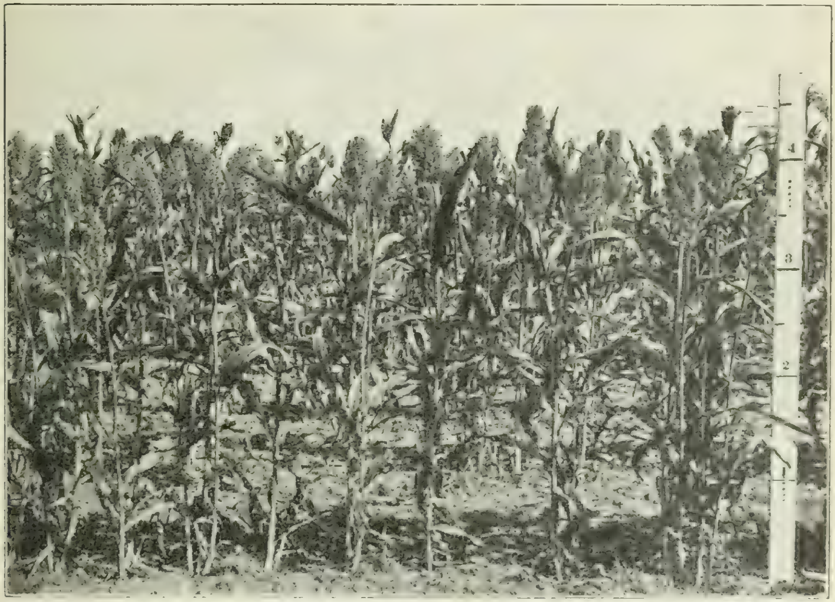

Fig. 5.—Plat of White durra with 100 per cent of the heads erect.

The durra group contains some very early varieties. The only one well known in this country is the common White durra (fig. 5), which has been called "White Egyptian corn," "Rice corn," and "Jerusalem corn," in the successive periods of its popularity. It matures as early as or slightly earlier than the milos. White durra apparently possesses true drought resistance also, and is productive, but shatters quite badly and is not liked for that reason and some minor ones. Some hybrids of this variety with Blackhull kafir have been under selection for three years and give promise of being valuable.

The kafirs usually require about three weeks longer than milo to mature under the same conditions. An early strain of Blackhull kafir (fig. 6) developed by the writer, through selection, matures about two weeks earlier than the ordinary kafirs and only three to five days later than milo. The old-fashioned White kafir, with white hulls, now rarely found in cultivation, was a semi-early sort and would make good selection stock if its heads were free from the boot and if it were not so susceptible to disease. Red kafir, which is normally a week or more earlier than the Blackhull in the low plains, seems to become proportionally later as it is carried westward to higher elevations. At the Amarillo Experiment Farm it has been consistently later than the Blackhull for several years.

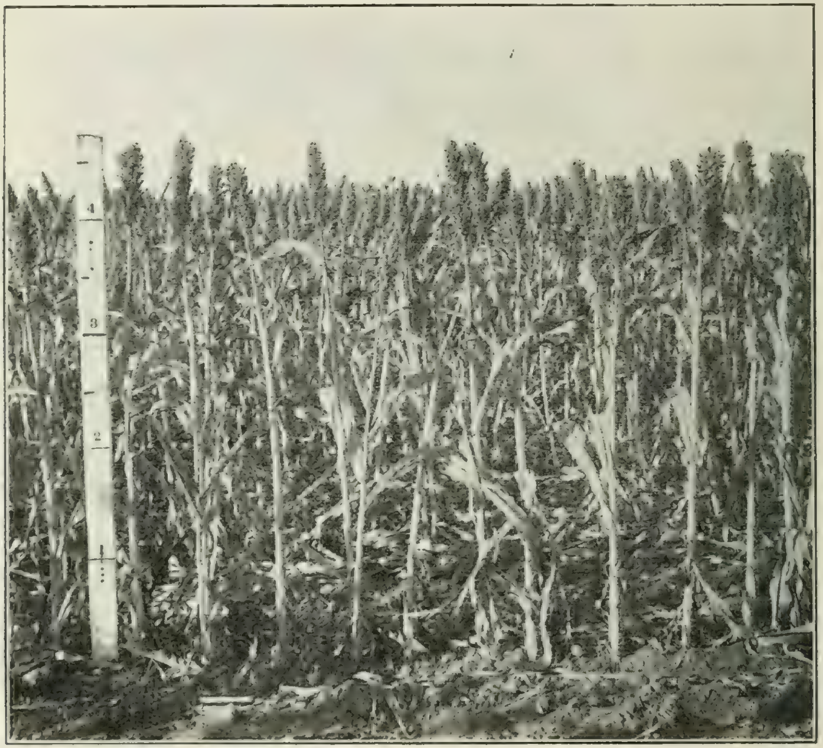

FIG. 6.—Plat of dwarf and early Blackhull kafir (G. I. No. 340).

The group of kowliangs from North China and Manchuria contains some varieties (fig. 7) which are naturally very early, especially among the brown-seeded sorts. Two or three (G. I. Nos. 171, 261, and 328) have matured in eighty to ninety days, thus proving earlier than the milos in the Panhandle of Texas. Some promising selections from them have been made in northern Colorado, in Nebraska, and in South Dakota. Coming, as they do, from latitude 40° or higher, they may prove able to germinate and grow at lower temperatures than the groups which have come from more southern latitudes.

EARLY CROPS AND EARLY SEASONAL RAINFALL.

The effect of earliness in permitting drought evasion is very important. Imagine two plants, one earlier than the other, but otherwise similar in all respects. The earlier plant, having a shorter growing period, not only uses less water, but uses it earlier in the season. This is of especial importance in those parts of the semiarid country where much of the seasonal rainfall occurs in April, May, and June. The earlier plant might be able to mature its crop of seed on the summer rainfall. On the other hand, the later plant might be crippled at a critical stage by the exhaustion of the soil moisture during dry weather in August. It is fairly certain that in much of the Great

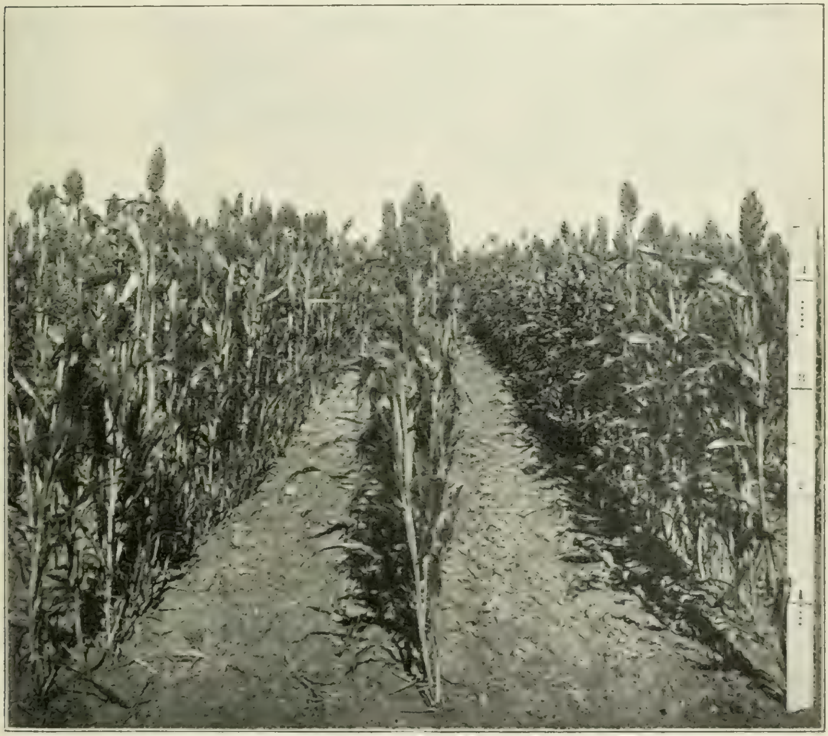

Fig. 7.—Plat of selected Brown kowliang (G. I. No. 171)

Plains region the greater part of the soil moisture in a field is not used by the growing crop, but is lost by evaporation, under the average tillage conditions.

Milos are earlier than kafirs, but are not known to be more truly drought resistant. At the experiment farm, Amarillo, Tex., under conditions of extreme drought from the middle of July until October, 1909, the milos yielded on the average 8.3 bushels and the kafirs only 5.5 bushels to the acre. In each crop the figures are the average of between 20 and 30 plats and show that the difference was really in the earliness of the milos as compared with the kafirs, the yields in normal years being about equal.

The writer has produced by selection a dwarf kafir (fig. 6) of the Blackhull variety which is nearly two weeks earlier than the ordinary strains. In 1908, a favorable season, it yielded less by 4.5 bushels than the average of the ordinary Blackhull varieties. In 1909 it yielded 14.4 bushels to the acre, while 20 ordinary strains averaged only 5 bushels, and the best of them yielded only 10.9 bushels. Part of the credit must probably be given to the dwarf stature because another selection, equally early but not dwarf, yielded only 10.7 bushels, as much, however, as any one of the later strains and twice as much as they averaged.

SELECTING FOR EARLINESS.

Earliness can be developed only by continuous selection. Such selections can be made either at heading time or at the time of ripening, but are preferably the results of records made at both periods. When the field or seed plat of the variety begins to head, a number of the earliest heads which are otherwise suitable for selection should be marked by means of tags on which is recorded the date of heading. When the heads on these selected stalks begin to show the characteristic colors and texture of the hard dough, or ripening stage, the date of ripening should be added to the tags. Other things being equal, those heads for which the shortest time has elapsed between heading and ripening are to be considered the earliest. These heads should be carefully saved separately and used for continuing the work another season.

In dry regions, where the amount of moisture in the soil is commonly the controlling factor in crop growth, the plants at the ends and sides of a field are often the first to produce heads, especially in dry seasons. This is because the outside plants have a larger area from which to draw moisture, or because run-off water often collects at the edges of fields and provides extra moisture. These early heads will be the first to ripen, but it does not follow that these plants are naturally earlier than the rest of the field.

DWARF STATURE.

For the grain-sorghum grower, a dwarf variety has two advantages over the taller strains. It requires less water and can be harvested with a grain header.

The larger the plant the more water it requires and the more it is likely to lose by transpiration. A small plant which can produce as much grain as a large plant will thus have a real advantage in a dry season. This is not true drought resistance, but merely a lower water requirement which permits drought evasion. The year 1909 was marked by severe drought during July, August, and September in the southern half of the Great Plains. At the Amarillo Experiment Farm, in Texas, 17 plats of milo gave an average yield of 6.8 bushels and 10 plats of dwarf milo an average yield of 11 bushels to the acre. The best plat of milo yielded at the rate of only 16.5 bushels, though in a low piece of ground, while the best dwarf milo yielded 23.2 bushels per acre. This advantage seems to be largely due to the smaller size of the plants of the dwarf variety and the consequent lower water requirement.

The development of an early dwarf strain of Blackhull kafir (fig. 6) has already been noted under the discussion of "Earliness" (p. 26). How much of its superiority was due to dwarfness and how much to earlier maturity can not be certainly known. Apparently about one-half was due to each cause.

The production of dwarf varieties has made possible the use of the grain header in harvesting the crop. Headers have been successfully raised on timbers until they will cut ordinary tall varieties, but this practice is not likely to become general. In case a successful row header is invented it is more likely to work well on low varieties than tall ones, especially in windy regions.

Selecting for dwarf stature raises the question of the ability of a plant to produce the same seed yields with a reduced stalk and leaf area. How far can reduction in the size and height of stems be carried without a reduction in the leaf area? How far can reduction of leaf area be carried without reducing grain production? These questions can not be answered except by long-continued investigations. It is much to be hoped that a series of careful and comprehensive experiments may some time accumulate data on the correlation of area of leaf surface and the power of seed production. The dwarf milo (fig. 8) and dwarf kafir are only 3 to 4 feet in height under conditions that make the normal crop 5 to 6 feet in height. The dwarf milos outyield the standard milos even in favorable seasons. The White durra, which is low, yields as much as the kafirs, which are of medium height or taller. The dwarf kafir seems likely to hold its own in a series of years. An extra-dwarf Brown kowliang has been secured in China. It grows to a height of about 2 feet, but, like most newly introduced sorghums, does not show high yielding power.

These crops have originated in subtropical lands and are commonly inclined to large growth. While they have been used chiefly for grain production in their native homes, it has been by more or less primitive peoples, and the returns have not been large. Since coming to this country, most of the standard varieties have been reduced in size and at the same time have increased in yielding power. The limit of profitable dwarfness has probably not been reached; it certainly has not been passed.

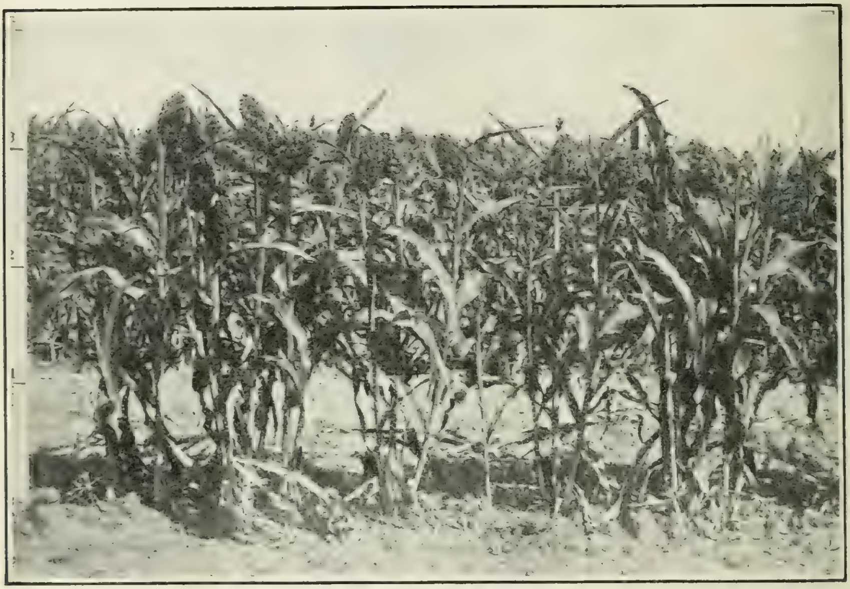

FIG. 8.—Plat of select Dwarf milo.

PRODUCTIVENESS.

OUTLINE OF THE PROBLEM.

The two keys to increased grain yields are better varieties and better methods of growing them. Better varieties means better filled and perhaps larger heads, erect and fully exserted from the boot, borne on stalks with fewer suckers and no branches. Better methods relate to proper and even spacing of stalks in the row and to thorough cultivation of the growing crop. They also include proper rotations and suitable tillage of the land when not in crop. Selections for better yields may naturally be continued as long as the crop is grown. No one may say what returns will finally be obtained. It may reasonably be hoped, by continued effort, to double the present average yields.

Better Yielding Varieties.

METHODS OF SELECTION.

The origin of a better yielding variety need not be at an experiment station or other like source; it may be produced by the farmer himself from his own fields. In any event, the grower must continue the selection from year to year. In its simplest form this will mean the selecting of stalks of desirable size and habit, bearing large and well-shaped heads (figs. 9 and 10), well loaded with plump grains. This requires, of course, that the work of selection be done in the field. Selections made in the bin or crib would be without value in this regard. The work should be done before harvesting begins, and a sufficient quantity selected to furnish plenty of seed for the farm crop of the next year. Where the harvesting is done by hand and the seed selections

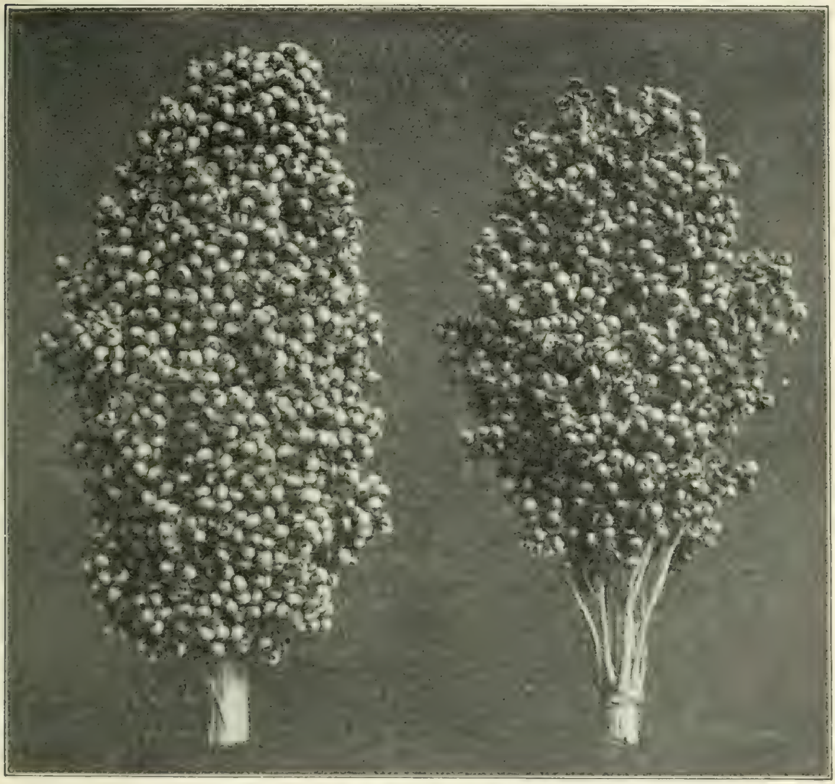

FIG. 9.—Two heads of milo, showing desirable and undesirable types.

have not been previously made, the two operations can be combined, though not usually with complete satisfaction. A small box fastened to the near side of the wagon bed will serve to receive the selected heads. Where machine heading is practiced this method is, of course, not possible.

DESIRABLE FORMS OF HEADS.

Well-filled heads.—It is important that the heads be well filled at the butts and tips, as in high-grade corn ears. Less attention has been given to this matter than it deserves. Figure 9 shows desirable and undesirable types in milo heads, and figure 10 shows desirable heads of Blackhull kafir. Milo may be taken as representing durras also, while the kafir may be regarded as the proper shape for kowliangs as well. The poorer head contains less grain and is therefore less productive. It also contains a larger proportion of fiber, and hence is less valuable as a feeding ration.

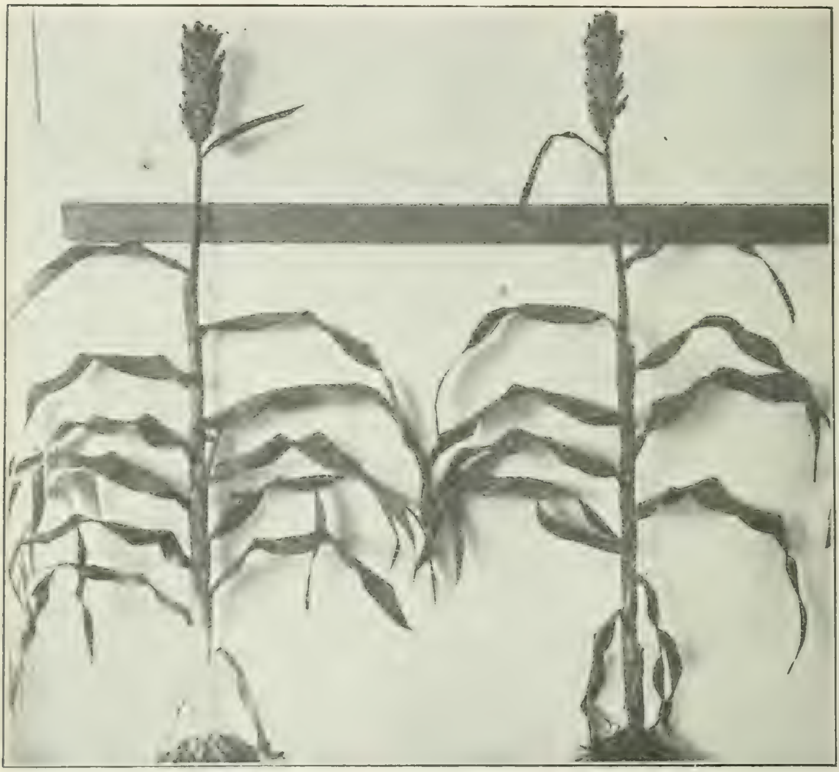

FIG. 10.—Two plants of Blackhull kafir, 5½ feet high, selected for high yielding power.

The heads selected should have shorter branches at the butt than in the rest of the head. These basal branches should be loaded with seed down to the point where they join the rachis or central stalk of the head. Long basal branches are likely to droop and finally break away under the combined stress of weight and wind.

Fully exserted heads.—It is also important that the head be fully exserted from the boot, or upper leaf sheath. No seed is produced on the included portion, which often becomes moldy or rotten if wet weather prevails. Corn worms and false army worms (*Laphygma frugiperda*) breed in such places and add to the injury. When these heads with spoiled butts are piled with others they are likely to cause damage to the whole heap. Varieties in which the heads are not fully exserted are also more difficult to harvest by hand or machine.

The main agricultural difference between White kafir and Blackhull kafir is that the heads of White kafir never become fully exserted from the boot. White kafir was the first kafir variety to come into general cultivation in this country, but has since been almost wholly discarded, largely for this reason. Blackhull kafir, the present popular variety, bears the heads normally entirely free from the boot (fig. 10).

Large heads.—In selecting for large heads the proportionate size of the stalks must always be considered. Not the largest head alone, but the largest possible head on the smallest stalk is the most desirable selection. The grain sorghums are for use where limited rainfall is the principal controlling factor in grain production. Larger plants use and transpire more water than smaller ones. Selection should be made where the stand is uniform and fairly thick, and should include the largest and best heads produced under such conditions. They should not be made from the outer row of the field or plat, or from places where the stand is thin, even though the larger heads are found in such places.

Average weight of heads.—Close spacing of stalks in the row or an unfavorable growing season reduces the size of the heads, even if they are well filled. The average weight of heads also varies with the stand and seasonal conditions. Wide spacing and favorable conditions cause larger and heavier heads. Under average field conditions the heads of milo, Dwarf milo, and kowliang weigh from 3 to 4 ounces, and those of durra varieties about 3 ounces each. In the kafir group the heads are normally much heavier, weighing from 4 to 6 ounces.

PERCENTAGE OF GRAIN IN TOTAL PLANT.

It is unfortunate that during the years when these plants were new in this country no records were kept of the proportion, by weight, of seed to total plant. Such data covering a considerable period of years at the same point would show not only the progress made, but would be an index to what might be expected in the future. During the past four years an attempt has been made to gather data on this subject. Even if the experiments had not been interrupted by drought, hail, and other environmental factors, four years is too short a period to yield conclusive data of this sort.

Table VI contains the average results obtained from a number of plats of several varieties. These results are not at all conclusive, but merely indicative of possibilities and are so offered. Of the four years considered, two have been favorable and two unfavorable crop years. The years 1906 and 1908, especially at the Amarillo Experiment Farm, were reasonably favorable seasons, as will be seen from the recorded yields. In 1908, however, the milo plats at Amarillo were almost wholly destroyed by hail, and must therefore be omitted. Their comparison with the Dwarf milo grown the same season would have been interesting. The years 1907 and 1909 were seasons of more or less drought by which the grain yields were usually reduced more than the vegetative growth. The figures for the four years are, therefore, not comparable.

TABLE VI.—*Percentage of grain in total weight of plants.*

Variety and number of plats averaged.	Grown on Texas farm at—	Year.	Row space per stalk.	Plants.	Grain.		
				Weight per acre.	Weight per acre.	Proportion in total plant.	Yield per acre.
			Inches.	*Pounds.*	*Pounds.*	*Per cent.*	*Bush.*
Milo:							
6	Amarillo	1907	8	5,375	1,434	26.5	24.7
3	do	1907	4	5,274	868	15.6	15.0
7	Dalhart[a]	1908	10	3,854	1,462	37.9	25.2
1	do	1908	30	3,150	830	26.3	14.3
3	Amarillo	1909	7	5,353	789	15.0	13.2
Dwarf milo:							
5	do	1908	8	6,208	2,366	38.1	40.8
1	Dalhart[a]	1908	10	4,400	1,461	33.2	25.2
1	do	1908	30	3,250	969	29.8	16.7
2	Amarillo	1909	8	3,807	1,007	25.7	18.3
Blackhull kafir:							
3	do	1906	9	10,317	2,692	26.1	44.9
5	do	1907	9	8,334	1,240	15.2	21.4
4	do	1907	5	9,145	1,155	12.6	19.9
5	do	1907	14	7,052	830	11.8	13.8
5	do	1908	10	7,798	1,966	25.2	32.8
Brown kowliang:							
1	Dalhart[a]	1908	23	2,000	725	36.2	12.5
5	Amarillo	1909	5	3,546	934	26.6	16.1
Shallu:							
1	do	1906	....	7,100	1,565	22.0	26.1

Another varying factor, which affects not only the yields but also the proportion of grain to plant, is the stand secured or the inches of row space afforded each stalk. In some of the experiments this factor was purposely varied, as in the two groups of milo and Blackhull kafir at Amarillo in 1907 and the milo and Dwarf milo at Dalhart in 1908. Unintentional variations occurred, caused by differences in the size and quality of the seed or in the nature or preparation of the land. These produced nearly as great differences in the stand as were caused by the different rates of seeding. The average row space is shown in column 4. It may be noted that from 7 to 8 inches is considered the proper row space for milos and 9 to 10 inches for kafirs under Panhandle conditions.

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[a] In cooperation with the Office of Dry-Land Agriculture Investigations.

The highest proportion of seed to plant was given by Dwarf milo at Amarillo and by milo at Dalhart in 1908. Two of the five plats of Dwarf milo at Amarillo, 1908, gave a proportion of over 40 per cent. As noted, the milos, which would have been comparable, were destroyed by hail. Of the seven plats of milo averaged at Dalhart, in 1908, three yielded higher than 40 per cent of grain, the highest being 47.2 per cent, which is probably the maximum yield for this crop.

Many other factors enter into the problem of increased productiveness. All the preceding discussion on earliness, drought resistance, and dwarf stature applies to this topic in some measure, as has been seen. However, the fact remains that no matter how great the performance of a plant under any given set of conditions it is possible to increase its producing power.

FREEDOM FROM SUCKERS AND BRANCHES.

Plant habits.—The habit of producing both suckers and branches is apparently characteristic of all sorghums, though in varying degrees. Suckers seem to be produced normally, but branches grow only under somewhat exceptional conditions. They will therefore be discussed separately.

Suckers.—Suckers are produced from the closely crowded lower nodes or joints of the stem just at the surface of the ground. In some plants suckers appear almost as early as the main stalk itself. In other cases they do not develop until the main stalk is well grown, or even after it has begun to mature its seed. Suckers may vary in number up to 10 or 15, according to the habit of the plant or to the particular environmental conditions, such as abundance of food and moisture. Though their heads are usually smaller, suckers differ from the main stalk chiefly in height and time of maturity. They are usually rather lower and almost always later in maturing, often very much so. Where the later part of a season is more favorable than the earlier, suckers often grow taller than the main stalk. Their difference in stature is objectionable only in harvesting, but their late ripening is a more serious matter.

The value of suckers in grain-sorghum crops is still a debated question. Many of the advertisements offering the seed of these crops dwell at length on their power to produce several stalks from one seed. Considering the cheapness of the seed of grain sorghums and the exceedingly small quantity (2 to 4 pounds) needed to plant an acre, the grower can well afford to require only a single stalk from a single seed. In a forage crop, where abundance of leaves is wanted, suckers may be very desirable, but in a grain crop requiring little seed, the weight of evidence is against them. Their existence may be partly justified by their help in making a fuller crop where a thin stand occurs. This is largely offset by their somewhat later maturing. It is a question whether the seed produced really pays for the food and moisture used.

Selections should then be made with the object of entirely removing suckers. This can best be done by selecting seeds from stalks which produce none. If the crop on which selection is begun does not contain any stalks wholly without suckers, the selection should be made from stalks which have only a single sucker, or in which the suckers are very small and appeared very late in the season. In this way the tendency to produce them will gradually be overcome. Closer planting in the drills will also have this effect. The combined effect of these two methods will materially reduce the number of suckers.

Branches.—Unlike suckers, branches do not appear until the main stalk is headed out and usually not until it has nearly ripened its seed. In all sorghums the main head is borne on a long peduncle arising from the uppermost node. There is no lateral bud at this node; at all other nodes, however, there is borne a single lateral bud, lying in the slight furrow or concavity of the internode and fully protected by the tough, convolute leaf sheath arising from the node and completely enveloping the internode. Branches are most likely to be produced when the weather remains warm and there is abundant moisture late in the season. The bud at the internode below the one bearing the terminal peduncle begins to develop into a plant. It forces its way out, either at the ligular collar of the sheath or by splitting the dorsal surface of the sheath, and then rapidly elongates, putting out leaves and finally a terminal seed head. It thus becomes a miniature stalk, growing on the parent stalk and exactly like it in all respects except size. In the meantime the buds at the successively lower nodes have been making similar growth. If the season is long enough and the moisture sufficiently abundant all these developing buds will become fruit-bearing stalks. In extreme cases the lateral buds on the oldest or uppermost branches will themselves develop into branches. This compound branching could go on indefinitely if permitted by seasonal conditions.

The heads on these branches are much smaller and less productive than those on the main stalk. They are also much later in maturing. Advertisements which state that a single stalk produces 4 to 10 large heads are wholly misleading. The branches themselves, arising first from the upper nodes, make the plant top-heavy and likely to lodge. The presence of branches interferes decidedly with the harvesting of the grain. When branching begins before the head on the main stalk is ripe its maturing is usually delayed. Branches use moisture that is often needed to be conserved for the next crop without making any adequate returns. These facts make the production of branches objectionable and they should be eliminated by selection and proper planting wherever they tend to occur.

Better Methods.

SCOPE OF TREATMENT.

Only methods of planting and the proper cultivation of the crop will be treated here. Rotations and general tillage to conserve moisture have their influence on crop improvement. In a new country, however, strict rotation systems can not be followed, and the general methods of dry farming can not be given in the limits of this paper. The principles are two: (1) Till so as to absorb the rainfall, (2) till so as to prevent evaporation. This subject has been fully treated elsewhere.[a]

PROPER STAND OR ROW SPACE.

The whole question of the proper stand or row space for the different varieties, under different conditions of soil and moisture, is one of which little is yet known. It is not the plant having the largest head which makes the heaviest acre yield, but the plant which can produce the largest head while growing in the smallest possible row space.

The results of four years' experiments at the Amarillo Experiment Farm, Texas, indicate that in general the kowliangs yield best with a stand of 1 stalk in each 5 or 6 inches of row; the milos and durras with 1 stalk in each 7 or 8 inches of row; and the kafirs with 1 stalk to each 9 or 10 inches of row. The rows are always 3½ feet apart and, as far as possible, the seeds are dropped singly in the rows (fig. 11). Under these conditions improved varieties in each of these three distinct groups give approximately the same yields. The Amarillo Experiment Farm has an elevation of 3,600 feet and an average annual rainfall of 22 inches, the larger part of which comes during the growing season. Further investigation, continuing the experiments through a longer period of years, may discover that better average yields will be produced at other spacings than those noted above.

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[a] See Farmers' Bulletin 266, entitled "Management of Soils to Conserve Moisture," which will be sent free on application to the Secretary of Agriculture, Washington D. C., or to any Member of Congress.

It is probable that at other locations better results will be obtained at other rates of planting than those given for Amarillo. The rate will vary with different elevations, different amounts of annual rainfall, or a different proportion of it during the growing season, and with differences in the character of the soil.

DRILLS OR HILLS.

Another important question which has not yet been made the subject of experiment to any great extent is the comparative value of planting in drills and in hills. For instance, 1 stalk every 6 inches in the row, or 2 stalks in a hill every foot, or 3 stalks in hills 18 inches apart, or 4 stalks in a hill and the hills 2 feet apart, would all give the same number of stalks per acre. Would they give the same results in bushels of grain per acre? The answer is not known. All the evidence at hand indicates that the advantage is in favor of a single stalk in a place. Experiments with corn seem to show that where from 3 to 5 kernels are planted in a hill, results are better if the kernels are scattered a few inches apart instead of being dropped in a bunch.

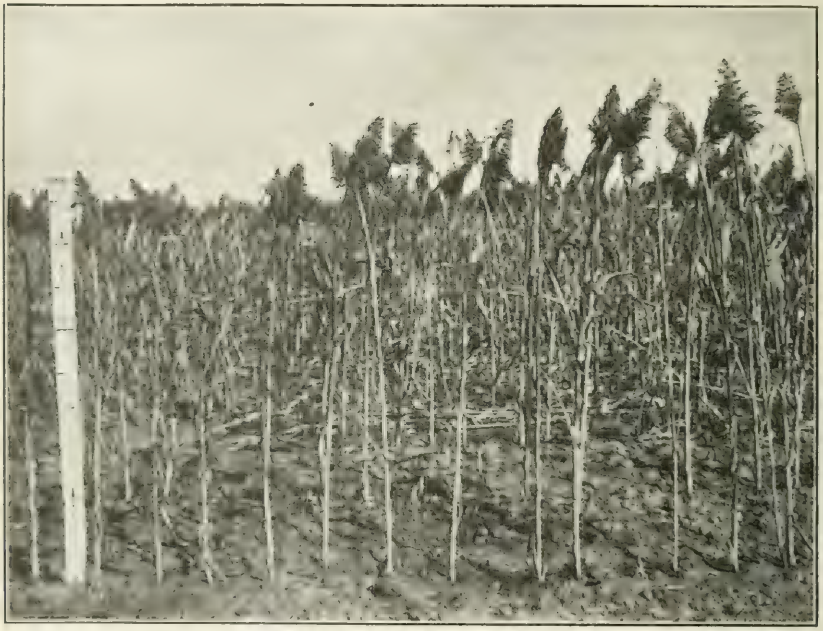

FIG. 11.—Plat of Brown kowliang, showing stalks singly and evenly spaced in the row.

Aside from the immediate question of yields, however, there are other reasons for preferring planting in drills rather than in hills. These reasons are connected with the production of suckers and pendent heads. Observation indicates that the fewest suckers and pendent heads are produced where the stalks stand singly. Whether this be true or not, it is certain that where the stalks stand one in a place it is much easier to determine if suckers are produced and to take steps to get rid of them by selection.

PLANTER PLATES.

The difficulty of attaining proper rates of planting is partly psychological and partly mechanical. When the psychological objection is overcome the mechanical hindrance can easily be removed. The first sorghums extensively cultivated in this country were the sorgos, which are forage crops and as such are planted thickly. The other leading groups, the milos and kafirs, were also first regarded as forage plants and sown thickly. Corn planters were equipped with "cane" plates which dropped 10 to 25 seeds in a foot of drill. In this way the idea of thick seeding for sorghums became firmly fixed in the minds of growers.

The value of the milos, kafirs, and durras as grain producers was only gradually recognized. The necessity of planting thinly where high grain yields are desired was realized even more slowly. Though this necessity is now being seen by the great body of grain-sorghum growers, there is not yet knowledge and agreement as to the proper rates of planting. These vary with different conditions and must be made the subject of extensive experiments. In the meantime the manufacturers of planters, though recognizing the demand for different plates, have had little data on which to create a suitable supply.

So far as the size of the seeds is concerned probably only two sets of plates will be necessary in order to drop a single seed at a time of any variety. The two sets will have the holes of different sizes and perhaps of slightly different shapes also. Milos and durras have rather large seeds, more or less round in outline. Kafirs and kowliangs have smaller and oval seeds.

Having these two sets of plates, certain variations in the rate of planting will be necessary in order to space properly the seeds of different varieties in the drill. For instance, the seeds of kafirs and kowliangs will drop singly through the same hole, but the one should be planted 10 inches apart and the other only 5 inches. This variation in rate may be effected either by the adjustment on the planter which changes the speed of the plate or by using plates drilled with different numbers of holes. Where plates with the proper number of holes are not purchasable, blank plates can be bought and drilled by a blacksmith. Care should be taken that the holes are countersunk on the lower side of the plate so that seeds will not become wedged in them.

ADAPTABILITY TO MACHINE HANDLING.

GENERAL STATEMENT.

More than ever is it true that the demand is for crops which may be handled readily and profitably by machinery at every stage in their production. This has long been true of the small-grain crops. Corn and cotton are examples, however, of two great staple crops which must still be gathered by hand. The economic pressure is so great, however, that many and varied efforts are being made to produce machines which will gather the ears of corn and the fleecy staple of the cotton.

HEADERS.

If the grain sorghums are to become staple crops on a large scale they must be adapted to machine handling. In the early years of the cultivation of milo and kafir as important crops there were two methods of harvesting in vogue where seed was desired. The first was to cut the crop, stalk and all, with the corn binder and cure it in the shock. The heads were then cut from the bundles with a knife, saw, or hatchet. The second method was to cut the heads by hand in the field. This was done with a knife, and the heads were thrown into a wagon body, like ears of corn. Both these methods are in common use to-day.

A header designed for use in heading kafir was invented some years ago. Though still in use to some extent, this header has never been a popular or widely used machine. It is a rather heavy machine, not running upon its own gear, but attached to the side of the wagon box. It is heavy and hard to handle, destructive to the wagon bed, and not susceptible of quick and wide adjustments. Moreover, it heads but a single row at a time, and is rather expensive, considering all these points. It can not be used on milo because of the large percentage of pendent heads, nor on Dwarf milo because of its low growth. In recent years many attempts have been made to invent a satisfactory row header which would be free from the objectionable features mentioned. So far these have not been successful, though one of them gives considerable promise.

Since the introduction of Dwarf milo it has been found possible to harvest it rapidly and satisfactorily by means of the ordinary grain header. The standard milo and the kafirs are too tall for easy handling with this machine. A few ingenious farmers have, however, contrived to raise their headers on planks to a point where they will gather these taller crops with a fair degree of satisfaction. One great advantage of the grain header is that it enables the farmer to harvest his small grains and his feeding grains with the same machine. As it cuts a number of rows at a time the work is done rapidly and a large area is easily harvested.

Two facts still prevent the general use of the grain header for these crops, namely, their height and the presence of pendent heads in some varieties. Here is a problem in selection for the farmer. Dwarf strains of kafir must be produced to equal the Dwarf milo already so popular. Varieties with erect heads must be had in all milos and durras.

PENDENT HEADS.

There are four great groups of grain-producing sorghums now under cultivation in this country. These are milo, durra, kafir, and kowliang. The first two groups originally had pendent heads (fig. 12). In the last two groups the heads are normally erect. The durras are but little grown because of the wasteful shattering of the seed, the irritating hairs on the glumes, and the pendent heads. A strain of White durra has been perfected in which 100 per cent of the heads are erect under all conditions. Improvement in the milos has not progressed so far. The percentage of erect heads varies from 50 to 95, depending, perhaps, more upon the season than on the particular strain. The character of pendent heads does not yield readily to selection. It doubtless can be entirely eliminated, however, by long-continued selections.

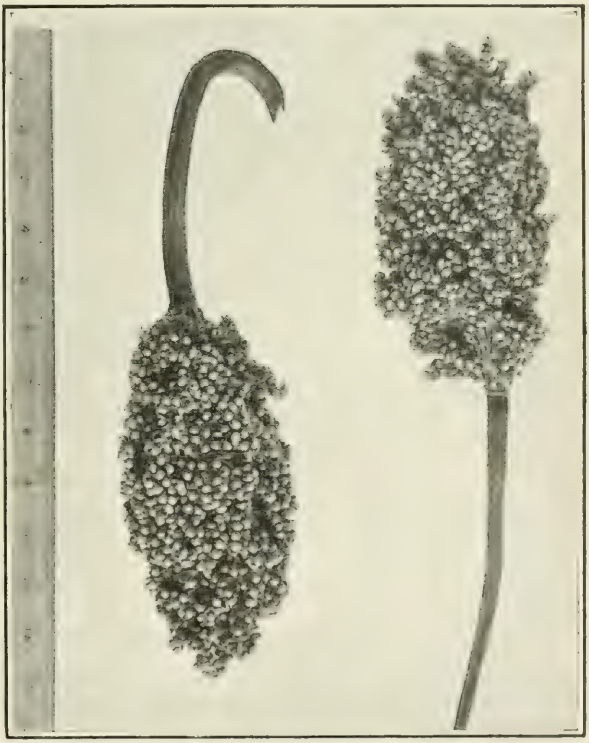

Fig. 12.—Milo heads; one pendent, one erect.

The tendency of the head to hang downward on a recurved peduncle is an inherent one. Because the largest heads are most likely to be pendent it has been held that the bending was caused by the weight of the head. This is apparently not true. The character, while inherent, finds expression most often in vigorous stalks. The same vigor of growth that produces a large head tends to produce also a pendent head. This increases the difficulty of solving the problem by selection. Other things being equal, vigorous plants producing large heads are desirable. If erect heads are normally found in the fields only on weaker and less vigorous stalks their continued selection might produce a weak and unprofitable variety. This fact has made progress toward perfect erectness much slower than it otherwise would have been.

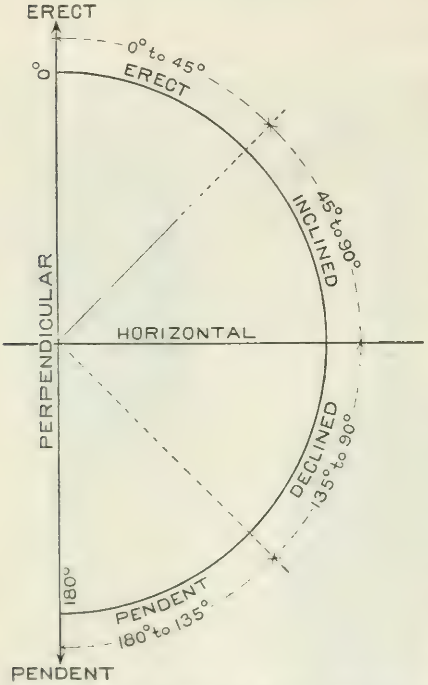

Fig. 13.--Diagram showing the named positions of heads of milo or durra.

The experiments show that the planting of these crops rather thickly in drills tends to prevent too great a vigor of growth and therefore checks the production of pendent heads without decreasing the yield. With the same number of plants per acre those planted in hills appear to produce more pendent heads than those spaced evenly in drills.

The diagram shown in figure 13 is tentatively suggested as an aid to those who are recording results in breeding these crops. The half circle through which the head may pass in shifting from the absolutely erect to the absolutely pendent position is divided in this diagram into four sectors of 45° each. The head is called erect when not inclined more than 45° from the perpendicular, because it is erect for all practical purposes of harvesting. Between 45° and the horizontal it is called inclined, and in the first 45° below the horizontal it is called declined, while below that it is called pendent. Though all such heads are not really pendent, the header must be set about as low in order to harvest them as if they were hanging straight down.

SUMMARY.

The grain-sorghum belt, broadly speaking, is the southern half of the Great Plains region, nearly 400 miles wide and 1,000 miles long. It is characterized by low rainfall and high evaporation, by varied soils and considerable elevation, with correspondingly shortened seasons. It is fitted to become a noted stock-feeding region.

The grain sorghums, including milos, durras, kafirs, and kowliangs, are of recent introduction and have become important only within the last twenty years. By their earliness, drought resistance, and adaptability they are especially fitted for growth under Great Plains conditions.

The grain is largely used for feeding stock on the farms where grown. Its feeding value is nearly equal to that of corn. The protein content averages higher than that of corn, the fat and fiber content lower. Any surplus is readily marketed as whole grain or as chops for feeding purposes. It is in much demand for poultry food, for which it is admirably suited. Over 25 per cent of the ingredients of prepared poultry foods in the eastern United States is kafir grain.

It seems probable that the meal can be used as readily as corn meal for human food and that both the meal and flour can be used in mixtures with wheat flour.

Kansas and Oklahoma grow annually over 1,250,000 acres. It is probable that an equal area is also grown in Texas. The grain-sorghum acreage in Kansas is nearly 10 per cent of the corn acreage, and in Oklahoma over 12 per cent. More than half the kafir and over 95 per cent of the milo are grown on the dry lands west of the ninety-eighth meridian. In this region the proportionate acreage of grain sorghums to corn is steadily increasing.

In spite of the less favorable conditions under which much of the crop is grown the average acre value of the grain sorghums in Kansas is higher than that of corn, and in Oklahoma it is 70 per cent as great.

The grain sorghums may be greatly improved through the selection of better varieties and the use of better methods. Improvement will be chiefly in the direction of (1) drought resistance, (2) earliness, (3) dwarf stature, (4) productiveness, (5) freedom from suckers and branches, and (6) erect heads.

The drought resistance of the grain sorghums is very important. It is probably a combination of several characters, some actually drought resistant, as controlled transpiration and a strong root system, others only drought evasive, as earliness and dwarfness.

Improvement in earliness is necessary in adapting the crop to regions having a short growing season. Early plants take advantage of early seasonal rainfall and also have lower water requirements. Milos, White durra, and some Brown kowliangs are normally early. An early dwarf strain of Blackhull kafir has been produced. Dwarf stature lowers the water requirement of the crop and permits heading by machinery.

Better yielding varieties may be produced by selecting for well-shaped, well-filled heads, fully exserted from the boot, and as large as possible in proportion to the size of the stalk.

The value of suckers in the grain-sorghum crops is doubtful. They are often shorter and usually later in maturing. Seed is so cheap and so little is used per acre that only a single stalk from each seed need be required. Branches should be eliminated, because their objectionable features render them utterly worthless for grain production.

Experiments show that under Panhandle conditions kowliangs give best yields with a stand of 1 stalk to each 5 or 6 inches of 3½-foot rows; milos and durras each 7 or 8 inches, and kafirs each 10 inches. Under different conditions the spacing will need to be varied somewhat.

Better results are probably secured from plants single in the drill than from the same number of plants in hills. Single stalks are also more easily selected and harvested and seem to produce fewer suckers. To plant single seeds of the different grain sorghums two sets of plates are needed, with holes of different sizes; one set for milos and durras and one for kafirs and kowliangs. To space different varieties properly in the drill, speed adjustments on the planter or plates with different numbers of holes will suffice.

The ordinary grain header harvests low varieties like dwarf milo with complete success. The invention of satisfactory row headers or the creation of other dwarf varieties will finally solve the harvesting problem.

Pendent heads are usual in some varieties. They can be slowly eliminated by selection and proper planting.

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BUREAU OF PLANT INDUSTRY—BULLETIN NO. 204.
B. T. GALLOWAY, *Chief of Bureau.*

AGRICULTURAL EXPLORATIONS IN THE FRUIT AND NUT ORCHARDS OF CHINA.

BY

FRANK N. MEYER,
Agricultural Explorer, Foreign Seed and
Plant Introduction.

Issued March 25, 1911.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 26, 1910.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 204 of the series of this Bureau a manuscript entitled "Agricultural Explorations in the Fruit and Nut Orchards of China," by Mr. Frank N. Meyer, Agricultural Explorer. This manuscript has been submitted for publication by Mr. David Fairchild, Agricultural Explorer in Charge of the Office of Foreign Seed and Plant Introduction.

Mr. Meyer's explorations in China, Manchuria, and Korea have brought to the attention of the Department many plants which promise to be of value to our agriculturists, either as forming the basis for new industries or as providing new and valuable strains of plants already known to us. Especially in fruits and nuts the Chinese Empire proves to be very rich, and as the similarity in soil and climate between the native habitat of these products and certain areas of the United States is close the possibility of introducing these new forms for direct cultivation and for breeding work is most promising.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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AGRICULTURAL EXPLORATIONS IN THE FRUIT AND NUT ORCHARDS OF CHINA.

INTRODUCTION.

The Chinese as a race are great lovers of fruits, and to satisfy their taste they grow these wherever there is a chance to do so. They understand the arts of grafting, budding, and layering; and although they are far less successful in their attempts to originate new varieties they are able to preserve those that have been secured. But as with crops in general so with fruits; particular districts are often characterized by peculiar kinds, and it frequently happens that a certain variety of fruit is found only in a single locality. This can be explained by the fact that certain varieties have apparently developed from seed obtained locally, and on account of the lack of skill in transplanting trees such varieties have never been successfully introduced into other localities. However, when one asks about these things one is generally told that certain fruits do not do well in other sections; that even if successfully transplanted they lose vigor or the fruits never acquire the right flavor, etc.

Another strange thing is that the Chinese never prune their fruit trees, although the trees grow dense and their branches interweave. When the branches become heavily loaded with fruit they are propped up or tied with straw rope. The only fruit which is really scientifically pruned is the grape; but here it is apparently a case of absolute necessity—no pruning, no fruit.

In transplanting, however, the cutting back of roots is carried to excess, and this is one of the reasons why tree planting in China is considered such a hazardous undertaking.

What is lacking, however, in the care of the trees is made up by the excellent care bestowed upon the soil. All orchards are cultivated except those of the jujube, which do not need it, but even these are kept free from weeds. The custom is to plow the orchards before the winter sets in, then to let the ground lie rough during that season, to plow it again in the spring, and to harrow and cultivate whenever the ground needs it, so as to conserve the subsoil moisture. Manuring is not much resorted to for fruit trees, as fertilizers of all kinds are too scarce; but crops are often grown between the trees, and perhaps the trees obtain extra nourishment from the manure supplied to these crops.

Of insecticides little is known. In some districts the bark of fruit trees is scraped scrupulously clean every winter. The trunks of peach trees are often whitewashed, apparently to kill the insects in the bark. Some fruit growers clean the trunks of their trees every year by applying a bundle of burning straw to them at the approach of spring. Of spraying, however, nothing is known. It is a good thing that there are so many parasites in China which prey upon scale and other insects; for if it were not for them, fruit growing would be almost impossible.

A peculiarity of Chinese taste is that the race as a whole does not care for soft fruits. One may even see high-class Chinese ladies selecting hard apricots from a basket containing a mixture of ripe and green ones and relishing the crunching of the hard fruit between their teeth. At dinner parties, fine-looking but extremely hard pears are served and are keenly relished by the most highly cultured Chinese. For this reason one finds that although raspberries, red currants, gooseberries, and various other small fruits grow wild in the mountains, one never sees them cultivated, and the fruit on these wild bushes is only sparingly picked.

PERSIMMONS.[a]

Chinese name, "Shi tze."

The persimmon (*Diospyros kaki*) is one of the most important tree fruits in northern China. Certain valleys are entirely given over to its cultivation, and the revenue derived from the sale of the fruit often forms the main source of income for certain districts. For instance, in the small village of Tai-dja-tchwang, near the large city of Pautingfu, Chihli Province, the writer was assured in January, 1908, that the persimmon crop of the previous autumn had brought in about 10,000 Mexican dollars, an amount which, though seemingly insignificant to us, is really a very large item in a small village in China. The most favored location for a persimmon orchard is at the foot of a hill or a mountain with a southern or eastern exposure, where the land consists of a warm decomposed granite soil that will allow the water to drain off easily and yet will retain enough to prevent the trees from suffering in case a drought should occur.

Trees are generally planted from 20 to 30 feet apart, and, as they are not fast growing, peaches and bush cherries are often grown between them for the first dozen years or so. When, however, the persimmons need the space, these secondary plantings are taken out

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[a] In the opinion of the writer the persimmons of northern China constitute a different group of these fruits from the various forms of *Diospyros kaki* found in Japan, but as *D. kaki* is so exceedingly variable it may be a very difficult matter to assign different varieties to well-defined groups.

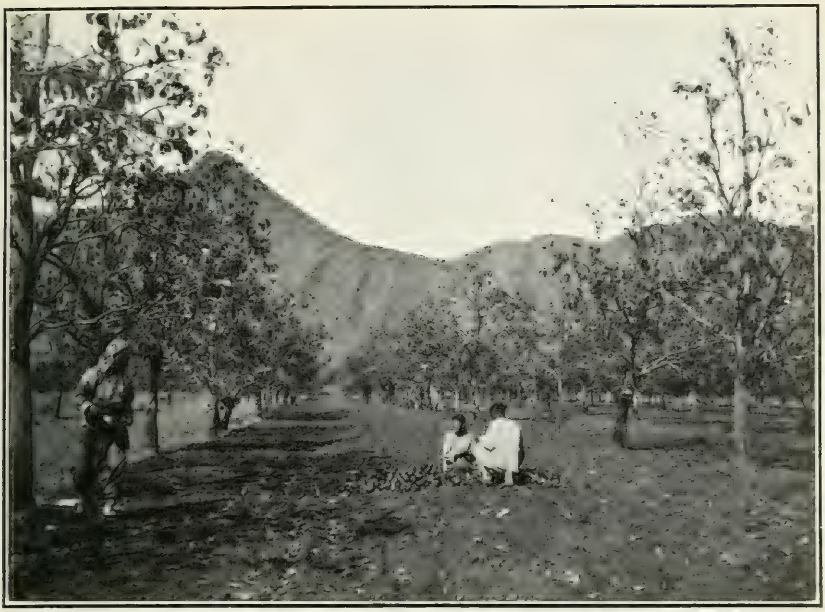

FIG. 1.—A THRIFTY PERSIMMON ORCHARD IN THE MING TOMBS VALLEY, NORTH OF PEKING.

Fruit pickers are sorting the fruit.

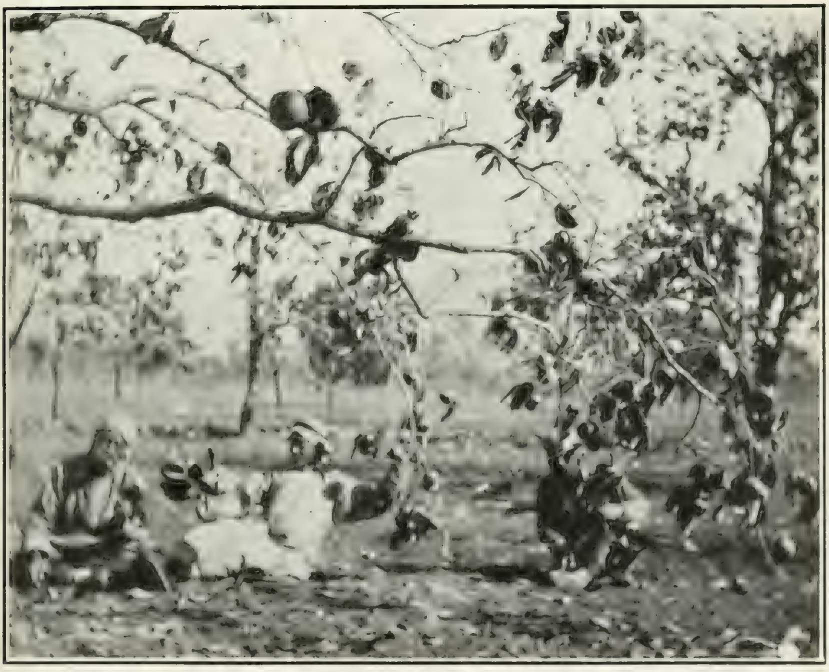

FIG. 2.—A NEAR VIEW OF SOME HEAVILY LOADED BRANCHES OF THE TAMOPAN PERSIMMON, A LARGE, SEEDLESS, NONASTRINGENT VARIETY.

Introduction Nos. 16912, 16913, 16921, 22350, 22362, and 22365.

and the soil is kept free from weeds and cultivated regularly. (See Pl. I, figs. 1 and 2.)

All the persimmons in northern China are ring budded or grafted upon a species growing wild in the mountains that bears small black fruit full of seeds. The ordinary Chinese name for this wild persimmon is "Ghae tsao," meaning black date, and statements have appeared in several papers that the Chinese use a black date—that is, a jujube—as stock for their persimmons. It is, however, an indisputable fact that the stock used in northern China is the *Diospyros lotus* (fig. 1). In central China probably other species are used, among which is at least one which has not yet been identified. (See Pl. III, fig. 1.)

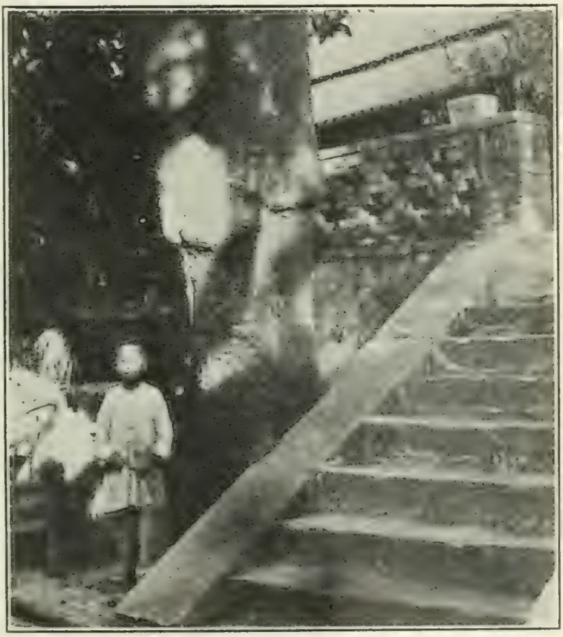

FIG. 1.—The trunk of a persimmon tree more than a century old in a temple courtyard near Taianfu, Shantung Province, China. Note the clear division between the stock (*Diospyros lotus*) and the graft (*D. kaki*).

CULTIVATED VARIETIES.

Many different varieties of persimmons are grown in China, varying in size, color, productivity, etc. Of those that came under the writer's notice there is one that stands out above all others in excellent qualities. The fruit of this particular variety has a bright orange-red color, grows to a large size, measuring from 3 to 5 inches in diameter and sometimes weighing more than a pound. It is perfectly seedless, is not astringent, and can be eaten even when green and hard. It stands shipping remarkably well. The fruit is of a peculiar shape, having an equatorial constriction, which makes it look as if two fruits had been joined, or, to use a more terse expression, as if somebody had sat upon it (fig. 2). The trees are very thrifty growers when once thoroughly established. They reach a height of from 30 to 50 feet, and though the young branches are very erect the older ones bend down a good deal because of the great weight of the fruit. The trees seem to bear very heavy crops in some years, while in other years the harvest is small. A drawback of a large crop is that the great weight of the fruit causes the large limbs to snap off unless they are propped or tied up. This, therefore, has to be done regularly. It seems that when the trees of this variety reach the age of 40 or 50 years they begin to decline in vigor; still, here and there old specimens may be seen that are near the century mark.

These large persimmons are mostly used when fresh. Foreigners in China are fond of eating them with a spoon, and after being kept in a cool place for some hours the fruit is very refreshing. They can be eaten while still hard, like apples. By careful handling and by keeping the persimmons at a low temperature they can be preserved for several months. To keep them through the winter the Chinese pile them in heaps, let them freeze thoroughly, and keep them frozen until they are needed. When wanted, they are simply put into a vessel with cold water to be thawed slowly, and then they are as good as when freshly picked. They can also be eaten when slightly frozen, like sherbet, and occasionally they are quite acceptable in that condition.

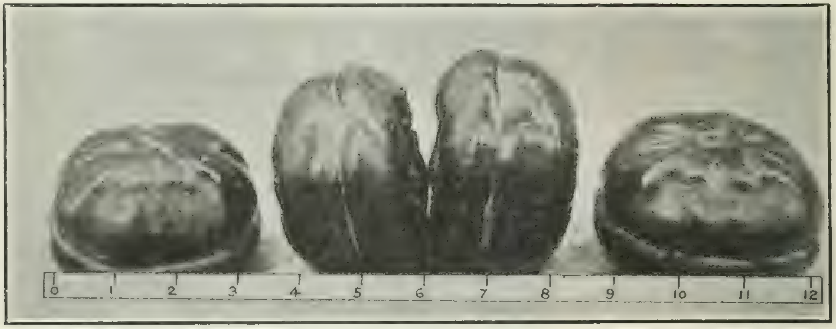

FIG. 2.—Four seedless Tamopan persimmons. Note the peculiar flattened shape of this fruit. Introduction Nos. 16912, 16913, 16921, 22350, 22362, and 22365.

The variety described here is called by the Chinese "Ta shi tze," meaning big persimmon, or "Ta mo pan shi tze," meaning big grindstone persimmon, on account of its large size and flattened shape (fig. 2; Pl. II).. An abbreviation of the last, namely, Tamopan, has been suggested by the pomologists of the United States Department of Agriculture as a suitable name for this variety in the United States. (S. P. I. Nos. 16912, 16913, 16921, 22350, 22362, and 22365).[a]

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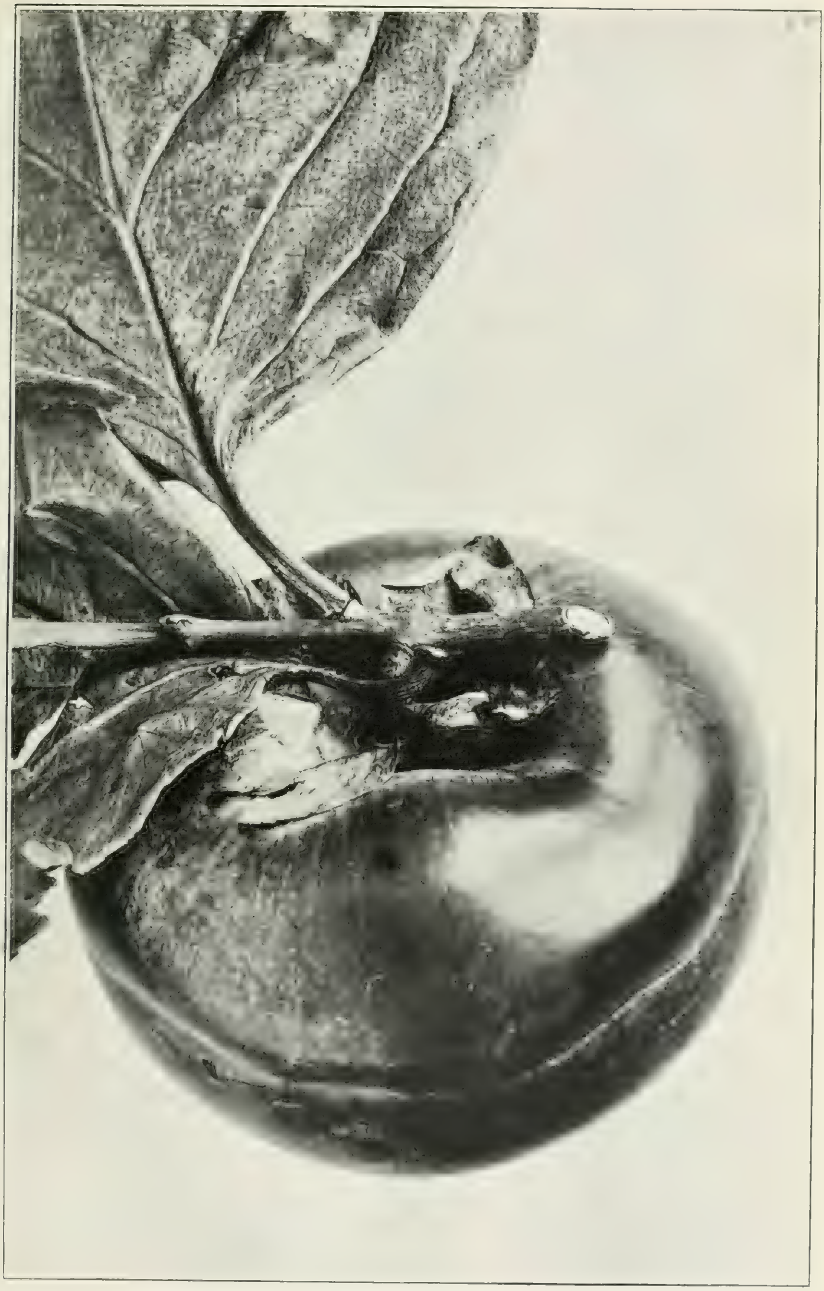
[a] The S. P. I. numbers mentioned in this bulletin refer to the numbers assigned by the Office of Foreign Seed and Plant Introduction to seeds and plants received from foreign countries and distributed with a view to determine their adaptability to conditions in the United States. For detailed information the reader is referred to the series of publications known as Inventories of Seeds and Plants Imported, of which 20 have been issued up to the present time.



TAMOPAN PERSIMMON.

A seedless variety containing so little tannin while hard that it may be eaten like an apple. Scions introduced in 1905 produced this fruit in Fayetteville, N. C., in 1910. (Natural size.)

Another variety, called "Shau mo pan shi tze," or small grindstone persimmon, resembles the first in every respect except as to the size of the fruit, which is smaller, being from 2 to 3 inches in diameter. For this reason the variety is not very generally planted. (S. P. I. No. 22366.)

Another kind, called "Siang shi tze," or sweet persimmon, is extremely rare; in fact, there seems to be only one tree of it, growing in an old temple yard in the Pang Mountains, east of Peking. The fruit is flat, but has no equatorial constriction. It also has seeds, generally from three to six. The skin is so tender that the fruit can not be shipped well unless frozen hard. It makes up for these defects by being particularly sweet and fresh in flavor. (S. P. I. Nos. 21910 and 22597.)

Another variety is called the "Lien hua shi tze," or lotus-flower persimmon (fig. 3). The appearance of the fruit of this variety is very peculiar. It is not large, only 2 inches in diameter, and bears besides the equatorial constriction two cross furrows, varying in depth in different fruits. Sometimes the incisions are so deep as to divide the top of the fruit into four lobes, resembling a coarse, waxy flower; hence, perhaps, the name lotus-flower persimmon. At other times, however, the incisions are so slight as merely to make the fruit appear undulated. The fruit is seedless and of a bright orange-red color. The flavor is not as fine, however, as that of the larger varieties mentioned before. The trees have the peculiarity of making a big warty growth where they have been united to the wild stock, and can always be recognized by that means.

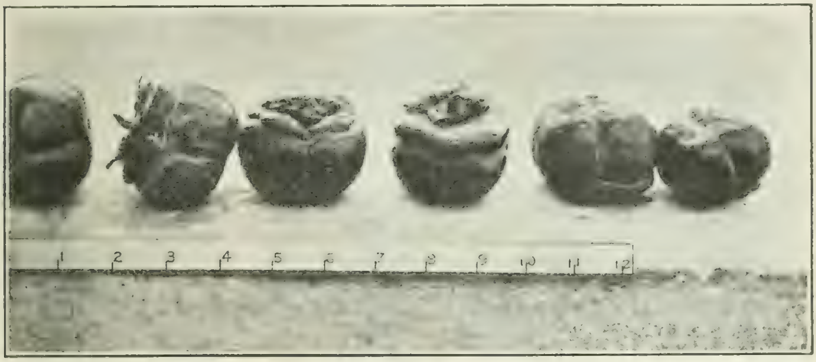


FIG. 3.—Seedless persimmons, showing their remarkable shape. This variety is called "Lien hua shi tze," or lotus-flower persimmon. Introduction Nos. 16910 and 22367.

The trees of this variety grow to a greater size than the other kinds, being from 60 to 80 feet tall, with heavy trunks. (See Pl. III, fig. 2.) They also live to a much greater age. In general they seem to be heavier bearers, but the fruit is several weeks later in ripening than that of the larger kinds. They have the habit of dropping their leaves before the fruit is entirely ripe, and then a large tree heavily laden with bright-orange fruit is one of the most beautiful objects in an autumn landscape. (S. P. I. Nos. 16910 and 22367.) [a]

Another variety bearing small fruit of a yellow color, which contains seeds, is called "New sien shi tze." The tree is a slow grower and has a whitish bark. It is a rare local variety, near Pautingfu, Chihli Province. (S. P. I. No. 22368.)

Another variety of small size, oblong shape, and scarlet color, containing seeds, and called "Whoe shi tze," or fire persimmon, comes from the same locality. (S. P. I. No. 22369.)

In the Provinces of Shantung, Shansi, Shensi, Honan, and Chekiang there are many other varieties of persimmons that are still waiting to be introduced.

Some of the less juicy varieties are used extensively in the manufacture of dried persimmons. This dried fruit closely resembles figs in appearance and is of an excellent flavor (fig. 4). It can be eaten raw or stewed, like dried peaches or apricots. Compote can be made from it and is very wholesome. It is very likely that new industries could be built up in those sections of our Southwestern States where these dry-fruited persimmons succeed well.

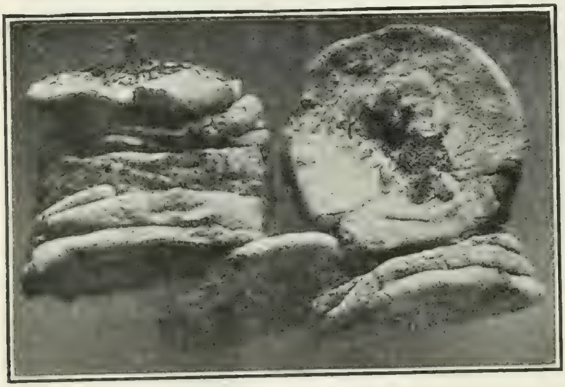


FIG. 4.—Large dried persimmons, said to have come from northern Honan, China. They are an excellent dried fruit, as extensively used in China as the dried fig is in America. Often eaten stewed like dried peaches or apricots.

The writer found a few specimens of apparently the true *Diospyros kaki* in a copse near the Tai ching kong temple, Laushan district, eastern Shantung. The trees look exactly like the cultivated *D. kaki*, but the fruit is greenish yellow and of an unpleasant flavor. It is the size of a small plum and the seeds are imperfect. The trees are very rare, and were seen only once. The fact that the priests call them the "Shan shi tze," or wild persimmon, may be an indication of their being the prototype from which the cultivated strains of persimmons, in northern China at least, have been derived.

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[a] This variety was apparently described by Carriere as *Diospyros costata* in the Revue Horticole, 1870, p. 132, also 1871, p. 410, where a colored drawing of the fruit is given. It seems, however, that the Costata variety of kaki of the American trade is quite a different variety, being of a pointed shape and only very slightly furrowed.

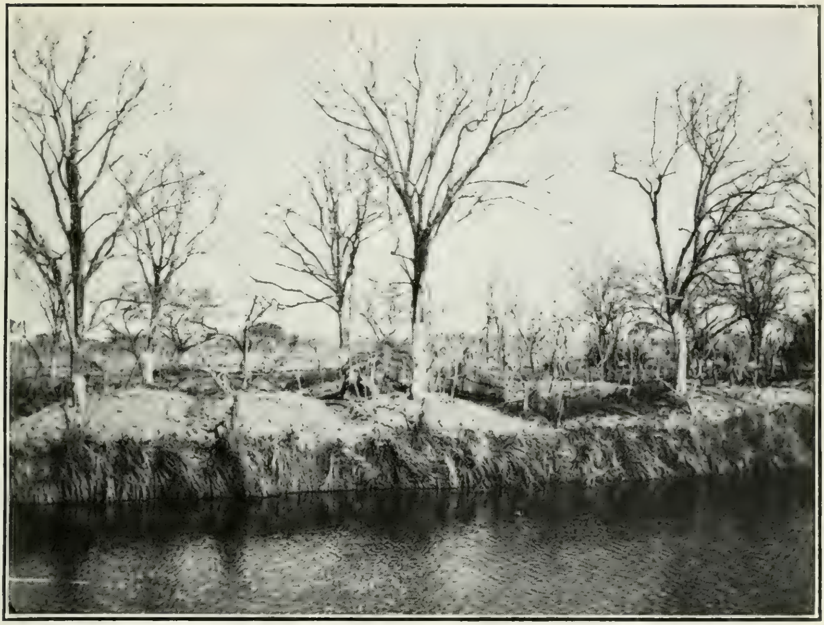

FIG. 1.—A GROVE OF PERSIMMON TREES NEAR HANGCHOW, CHEKIANG PROVINCE, CENTRAL CHINA, GRAFTED ON THE WHITE-BARKED VARIETY OF STOCK.

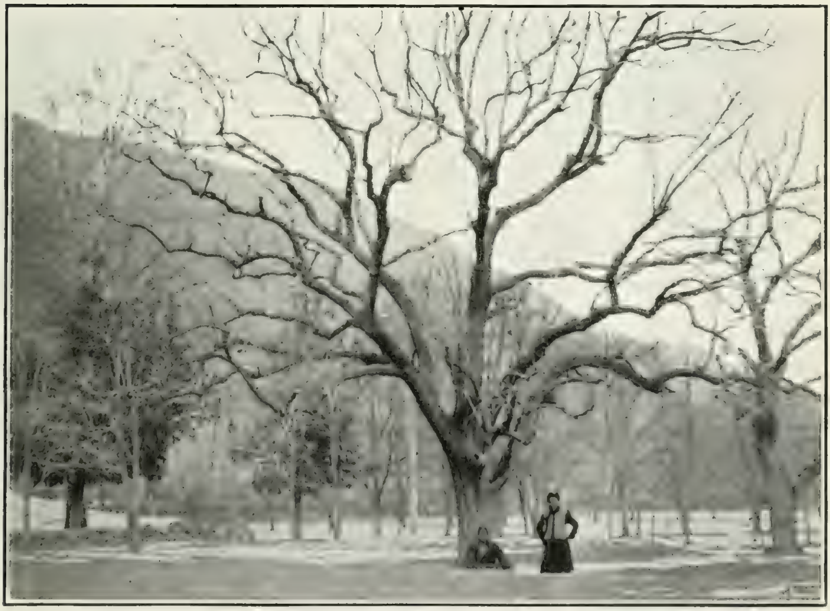

FIG. 2.—A LARGE SPECIMEN OF THE LOTUS-FLOWER PERSIMMON TREE AT TAIDJATSOA, CHIHLI PROVINCE, CHINA.

Introduction Nos. 16910 and 22367.

THE WILD PERSIMMON.

[CHINESE NAME, "Ghae tsao," meaning black date.]

The wild persimmon (*Diospyros lotus*), upon which the natives of northern China bud and graft all their cultivated varieties, grows wild here and there in the mountains of northern China (fig. 5). In its native haunts it seems to love protected rocky situations in ravines along small mountain streams. The trees do not grow large; sometimes they are more in the nature of a big shrub. When given space and good soil, however, they develop into good-sized trees with dense heads of dark-green foliage. Old trees also have a very dark-colored trunk which is deeply grooved and furrowed (fig. 6).

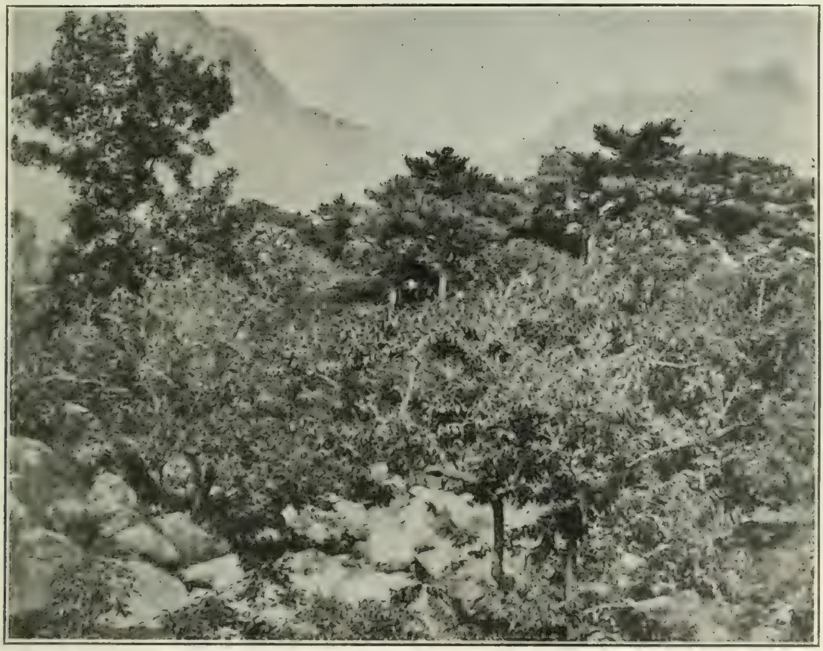

FIG. 5.—The wild persimmon tree (*Diospyros lotus*) in its native habitat in the mountains near Changli, Chihli Province, China. This tree is ordinarily used as a stock for the large-fruited edible persimmon. Introduction Nos. 17906 and 17907.

It is a most productive bearer, being literally covered in the autumn with small blackish fruits the size of large cherries. The fruits are edible when soft or after a frost, but there is very little flesh to them, as they contain from three to five rather large seeds. Children are very fond of them, and a tree of this variety in a yard will certainly be worth its space.

In China, where everything is of value, this fruit is sold in large quantities, especially in the neighborhood of Changli, Chihli Province, and travelers passing through on the railroad from Peking to Mukden in the fall of the year are certain to see boys and men coming to the train and offering baskets of these small persimmons, together with walnuts, grapes, chestnuts, peanuts, and other natural delicacies.

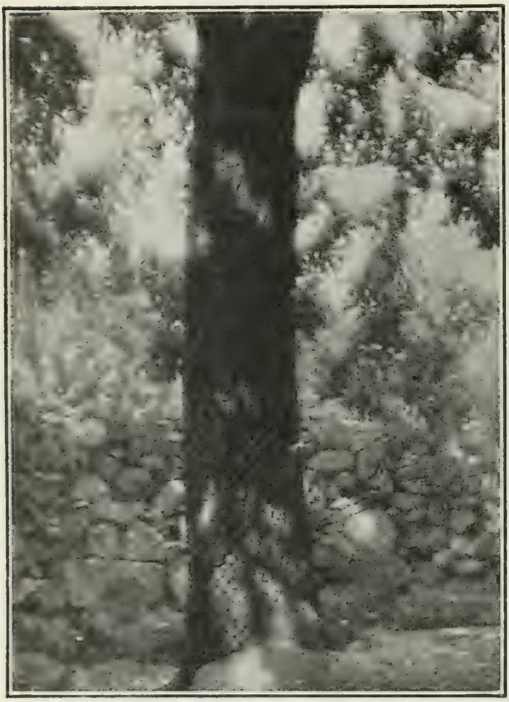
FIG. 6.—The trunk of a large specimen of the wild persimmon tree (*Diospyros lotus*), showing its black bark with deep irregular grooves.

In their wild state the trees vary considerably in productiveness, size, and color of the fruit. Near Changli there are a few trees that have decidedly elongated berries, covered with a bluish bloom and very sweet to the taste. In the Pangshan district there are one or two trees bearing globular fruit, which is perfectly seedless; and in the mountains southwest of Pautingfu, small, yellow-fruited varieties are occasionally found.

As a stock, however, this persimmon may give to its grafted host a much longer life than the native American persimmon seems to be able to, for in China all the cultivated persimmons grow much older than they do in America. Of some varieties there, one finds trees grafted on this *D. lotus* that are centuries old and still very productive. (See fig. 1.) (S. P. I. Nos. 17173, 17905 to 17907, 18266, 18599, 19395, 22370, and 22599.)

PEACHES.

[CHINESE NAME, "Tau" and numerous variations.]

CULTIVATED VARIETIES.

As is well known, China is supposed to be the original home of the peach (*Amygdalus persica*). Whether this is correct has not been settled, for peaches have been found wild in the southern Himalayas near Mussuri, according to Royle, and in the province of Ghilan in

Persia, according to Buhse;[a] and the writer has been assured by native Persians and by travelers that small hard peaches occur wild in the mountains of northern Persia. But the question of whether or not the peach came from China we shall not raise here. So far as we know at present, three important strains of peaches have been developed in China, i. e., the Chinese Cling group, the Honey group, and the Peento group. That these groups have proved more successful in the southern portions of the United States than the varieties introduced from Europe is also certain, and that some of our most important commercial varieties to-day are wholly or partly of Chinese origin has been proved indisputably.[b]

The Chinese Cling group reaches its greatest perfection in those parts of China where the summer is hot and fairly dry and the winter moderately cold and dry. The Honey group is to be found mainly in the more southern and central parts, where the summers are hot and humid, while the winters are mild and wet. The last group, the "peen" peaches, apparently thrives everywhere, from the extreme south to the north; but it is the least grown of all the peaches in China, and it is only in the extreme south where the better, larger varieties of peaches fail that the little Peen peaches are cultivated somewhat extensively.

In China the thriftiest and healthiest peach trees are always seen at the foot of a mountain or a hill, growing in decomposed rocky or sandy soil, and it is in such locations also that the fruit has the finest flavor. In the neighborhood of large cities, like Shanghai, one finds peaches grown on rather low, rich land, but the trees have so many diseases to battle with and the fruit is so watery that one clearly sees that such places are not congenial to the habits of the peach.

In general, a Chinese peach orchard contains many different varieties. Seedlings and budded trees are mixed in an irregular planting. Pruning is not resorted to, but the soil is kept in a high state of cultivation so as to minimize the danger of the trees suffering from a lack of sufficient moisture. In case the season is very dry and water is available, the Chinese often irrigate their trees, for it gives them much larger fruit.

As to the variation of peaches in China, it is as great as, if not greater than, anywhere else. Of the Chinese Cling group, there are some most excellent varieties to be found in northern China. The best of them all is the "Fei tau," or Fei peach (see Pl. IV, fig. 1), Feicheng being the name of a village where the orchards are located. These peaches grow to a large size, often weighing over 1 pound apiece, and are of a soft, pale-yellowish color externally, with a slight blush on one side. The meat is white except near the stone, where it is slightly red. The fruit is a clingstone with a very large, pointed stone. The skin is very downy. The fruit ripens in the early and middle part of October and has an excellent flavor, being sweet and aromatic. It possesses extraordinary keeping and shipping qualities, keeping until February if wrapped in soft tissue paper. Its shipping qualities are such that it is carried in baskets, slung on poles across the shoulders of coolies, from Feitcheng to Peking, a journey of eight days on foot. So famous is this peach that it is sent every year as a tribute or present to the imperial court at Peking; and even right on the spot where this fruit grows the most perfect specimens retail at from 10 to 15 cents apiece in Mexican money, a price which is about two-thirds that of the average daily wages of the Chinese field laborer.

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[a] Hehn, Victor. Kulturpflanzen und Hausthiere, in ihrem Übergang aus Asien, etc.

[b] Powell, G. Harold. The Chinese Cling Group of Peaches. Bulletin 54, Delaware College Agricultural Experiment Station.

Another fine variety of peach grows near Hsinchow, south of Pautingfu, in the Chihli Province. The writer has seen specimens of this peach in Tientsin that were fully as large as good-sized navel oranges. They are of a pale, whitish-green color, with almost no blush, and very juicy and sweet, though not aromatic like the Fei peach. They are clingstones, the seed being medium large. They are not very downy, and ripen toward the end of October. They are exported to all the large cities of northern China, and can rarely be purchased in the open markets, as they are apparently nearly always supplied to private customers.

Another variety, found near Shanghai, is the "Tsu mau tau," a large fruit with whitish meat, changing to red near the stone, something like our Chinese Cling.

There are several strains of the "Hong tau," or red peach, growing in the Chekiang, Chihli, Shantung, and Shansi provinces, and even in Manchuria. Some of these peaches are blood red and when cut through look more like a beet root than anything else. One variety in Shansi is even called the "Rho tau," or beef peach, so much does it resemble meat. These, so far as has been observed, are not so sweet as the Peento group of peaches.

Of the Honey peaches there are also several varieties in China. In the Shantung Province, especially, there seem to be some very fine types. One which the writer ate in Taingtau was a large, white-meated freestone of a very pronounced Honey-type shape, called "Yang tau" by the natives.

Of the flat or Peen peaches there are several varieties. Some thrive in the moist southern regions of the Empire, others are to be

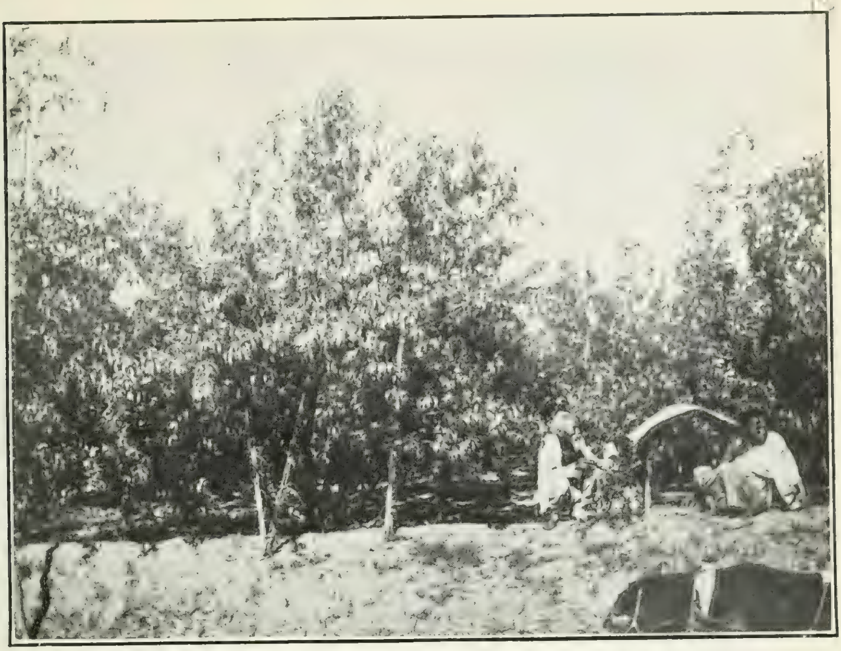

FIG. 1.—VIEW IN AN ORCHARD OF THE FAMOUS FEI PEACHES AT FEITCHENG, SHANTUNG PROVINCE, CHINA.

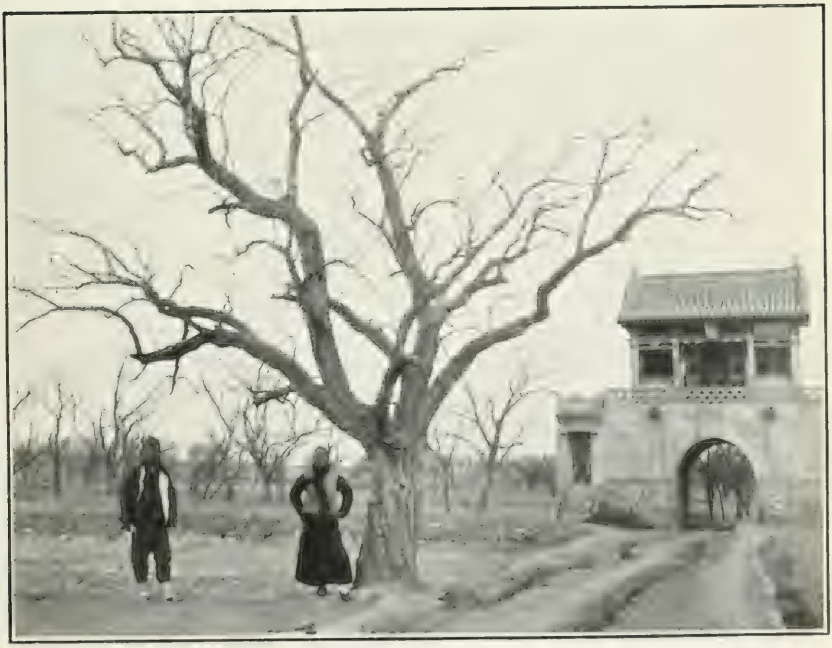

FIG. 2.—A LARGE SPECIMEN OF A CHINESE JUJUBE TREE, CALLED THE "MU SHING HONG TSAO," OR POINTED JUJUBE, AT TSINGYUENHSIEN, SHANSI PROVINCE, CHINA.

found even at the edge of Manchuria. The writer has noticed greenish, red, yellowish, and white types, varying a good deal in size and appearance.

In the Chekiang Province there is a red flat peach which ripens in June and is called "Hong peento," or red flat peach. A white variety occurs in the neighborhood of Shanghai, bearing the name "Pak peento," meaning white flat peach. In the Shantung Province there are some excellent sweet flat peaches. Near Kiaochou one variety is called "Pai pien tau" and is deliciously sweet and juicy. A yellowish variety coming from central Shantung is also very fine. It is called "Huang peento," or yellow flat peach.

There are several forms of peaches in China that are intermediate between the different groups and can not be assigned to classes by themselves.

How far the peaches of northern China may make it possible for us to extend the peach belt northward by using them in hybridization is a question that might be well worth consideration. In the city of Kirin, Manchuria, where the thermometer sometimes drops to −40° F., there grows a small-fruited variety in a temple garden; and Prof. N. E. Hansen, of the South Dakota State College of Agriculture, has stated that rumors reached him on his last trip through Siberia of peaches growing in northeastern Mongolia, where the winters are very severe and very little or no snow covers the ground at that season.

One great difficulty in shipping bud wood of peaches is the fact that it does not travel very well. On the long journey over sea and land from China to America the buds become spoiled, although the wood may remain green and healthy. Owing in part to this fact, many excellent varieties of Chinese peaches have not as yet been successfully introduced.

NECTARINES.

Nectarines (*Amygdalus persica nectarina*) are apparently very rare in China, as the writer heard of them only a few times. Bud wood was obtained but once, and that was in Kwangning, Manchuria, where this fruit is called "Ta hsing-mei."

THE ORIGINAL WILD PEACH.

[Chinese name, "Shan tau shu," meaning wild peach tree.]

In connection with the cultivated peaches a few words about a peculiar wild Amygdalus will not be out of place. This species, *Amygdalus davidiana*, was observed growing wild on the rocky south slopes of mountains in the neighborhood of Peking, Jehol, and in the neighborhood of Taitchow, Shansi Province (fig. 7). The plants in the wild state always grow shrubby and are from a few feet to 10 or 12 feet high; but when planted in gardens as ornamentals, as one often sees them in Peking, Tientsin, Chinanfu, etc., they reach a height of 30 to 40 feet and form a single trunk, sometimes over a foot in diameter (see Pl. V, fig. 1). The cultivated plants vary a good deal in the color of their flowers, which ranges from white to dark rose. The flowering period lasts but a very short time, but as the trees bear graceful dark-green foliage after their flowering they are quite ornamental.

The greatest value, however, that these wild peaches have for us is not so much in their ornamental appearance as in their use as a stock for almost all members of the stone-fruit group. The Chinese graft and bud upon them not only peaches but plums, "bush cherries" (*Prunus tomentosa*), flowering plums, and cherries, and all of these thrive upon this stock. They are also remarkably drought resistant, and as far as our preliminary experiments show they thrive equally well at Ames, Iowa, and at San Antonio, Tex. From the nature of the tree it will do especially well in those sections of the United States where there is only a limited summer rainfall and where winter temperatures do not fall too low.

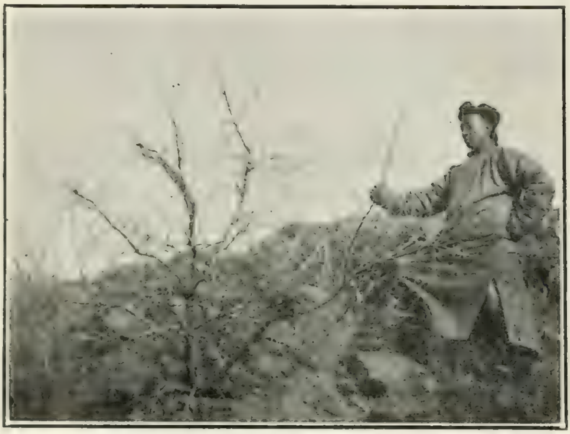

FIG. 7.—A tree of the wild peach (*Amygdalus davidiana*) growing among rocks in the mountains near Fangshan, Chihli Province, China. This variety is commonly used as a stock in China. Introduction No. 22009.

The kernels of these wild peaches are used to flavor confectionery and some special dishes, but as they are full of prussic acid only very small quantities are used. The stones themselves are often made into rosaries, which the Buddhist priests use in their worship. Being deeply and irregularly grooved they are very artistic when cleaned and polished. (S. P. I. Nos. 17470, 17729 to 17731, 18262, 18595, 21227, 21908, and 22009.)

APRICOTS.

[CHINESE NAME, "Hsing," and other names.]

The apricot (*Prunus armeniaca*) is found in a wild state in many places in northern China, Manchuria, and northern Korea, and therefore it is no surprise to find it growing as a fruit tree on a large

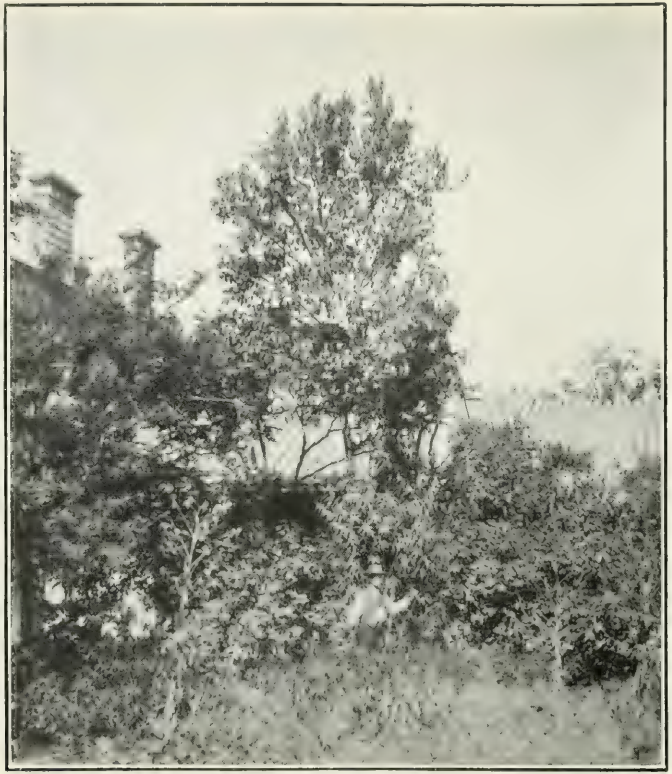

FIG. 1.—THE WILD PEACH (AMYGDALUS DAVIDIANA) COMMONLY USED AS A STOCK FOR STONE FRUITS.

This specimen, more than 40 feet tall, is in the grounds of the German Legation at Peking.

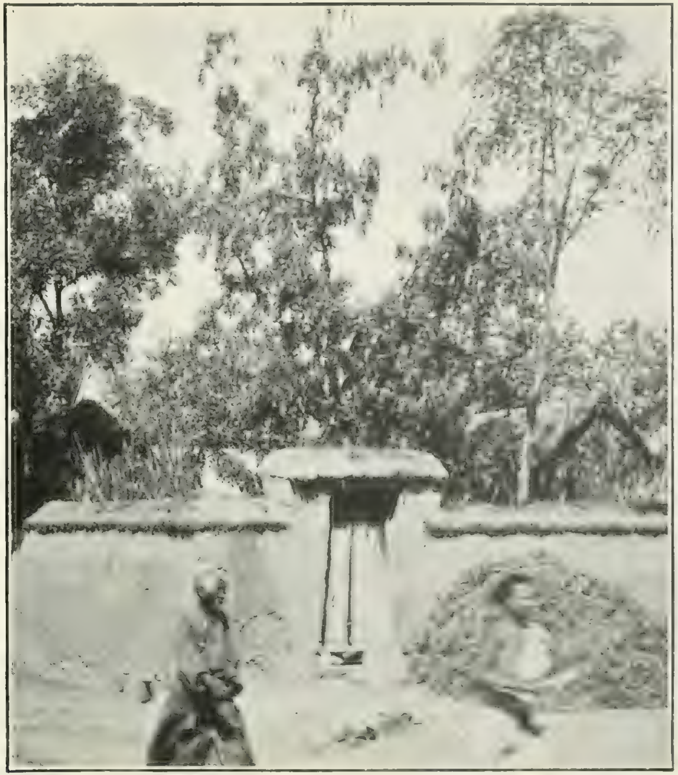

FIG. 2.—A HEAVILY LOADED TSAO OR CHINESE JUJUBE TREE (ZIZYPHUS SATIVA) IN A COMPOUND NEAR NINYANG, SHANTUNG PROVINCE, CHINA.

scale. There are red, orange, yellow, red-and-white, and white-spotted varieties in cultivation. In size there is also great variation.

The Chinese bud and graft their apricots upon seedling apricot stock and also upon the wild peach (*Amygdalus davidiana*). The trees generally are not grown in regular orchards, but in small lots of a few trees each. A decomposed granite or gravelly soil is preferred, and the trees thrive especially well on terraces on the mountain sides.

The Shantung Province is famous for its fine apricots, and there are several varieties there that are well worth introducing. There is also a strain of apricots in the Chihli Province that has sweet edible kernels. These kernels are sold as almonds and have created the impression that the almond occurs in China. However, I have never seen a single true almond tree in China, although I believe that in certain sections they would grow to perfection.

Apricots are nearly always eaten in China when not quite ripe, even small, hard, green fruit being eagerly eaten in early summer. Some of the less juicy and more acid varieties are cut in half and dried and sold during the winter months as delicacies. The Chinese say that a tea made from these apricots is very wholesome, purifying the blood and being laxative. Various compotes are made from the ripe and partly ripe fruit in which sugar and honey play a considerable part. Some of these delicacies are very good. (S. P. I. Nos. 17152, 17154, 20067, 20072, 22344, 22437, 22444 to 22446, and 22580.)

WILD APRICOTS OF NORTHERN CHINA, MANCHURIA, EASTERN SIBERIA, AND NORTHERN KOREA.

It has been proved that the apricot is able to stand far more cold and drought than is at present supposed. One finds the shrubby wild apricots all over the mountains of northern China and southern Manchuria, and forms which develop into regular trees occur in northern Korea, northern Manchuria, and eastern Siberia. The writer observed giant apricot trees growing in a mountain ravine near Tchangsong in northern Korea, fully 40 feet tall, the trunk of one measuring 10 feet in circumference. The fruit, though, is small and worthless, but as a stock plant and for hybridization purposes it might be of very great value.

That in the future large sections of the United States will be able to grow apricots where now there are none can be readily shown, for some of these Asiatic apricots have proved to be hardy at Boston, Mass., and even in the trying climate of Wisconsin. At the present time there is a large specimen of a central Asian apricot tree growing in the grounds of the State Agricultural Experiment Station at

Madison, Wis., and it has been thriving there for at least thirty years, without having suffered in the least from the low temperatures occasionally experienced there. (S. P. I. Nos. 16917, 18290, 19489, and 20068 to 20071.)

PLUMS.

The plum (*Prunus* sp.) is a fruit which is not very highly esteemed in China. Whether this is on account of its softness and its nonshipping qualities or whether because of its sourness we do not know, but plums do not form a big item in the fruit production of China.

The Shantung Province, which is the finest fruit-growing region of northern China, supplies the best plums, large red and yellow ones being even exported to various coast towns. In Peking one is able to obtain plums of one variety as late as the middle of November. This particular plum is yellowish green, with a slight blush on one side, and is of quite a sweet flavor. It is a freestone. (S. P. I. No. 17913.) There are a few other varieties grown in the neighborhood of Peking, but the writer saw the trees only when the fruit was gone and therefore could not obtain samples. Plums are grown in several places in Manchuria, as in Kwangning, Liaoyang, and Kirin. In this last place there is a red-fruited variety of medium size, not very fine eating, but excellent for preserves. As the cold gets very intense in Kirin, these plums may prove to be valuable in breeding. (S. P. I. No. 20241.)

The farthest north, however, that the writer found plums was in Khabarovsk. There, in the garden of Gen. M. Vedenski, he obtained bud wood of a yellow plum of good flavor that is able to withstand, unprotected, winter temperatures of −45° F. (S. P. I. No. 19605.)

In central China are found peculiar plums. One apparently belongs to the species *Prunus triflora*. Another kind produces green fruit which is exported extensively, preserved in sirup or dried. It is of a beautiful green color and is much used in confectionery. The local name is "Shing mae." It is probably a form of *Prunus mume*.

There is another plum which has the appearance of an apricot, but is sour like the plum. It is very fragrant, has a downy, dull-yellow skin, and is a clingstone. The stones are peculiarly grooved, looking like wild-almond stones. This plum may be a hybrid between an apricot and a peach, or perhaps a new kind altogether.

In the Shantung Province there grows a plumcot, called by the Chinese "Lishing," which means plum-apricot. The fruit is large, red, and very sweet and aromatic. There seem to be about three known varieties of it, and the best ones are said to come from the neighborhood of Chingchowfu, Shantung Province. The few trees of this remarkable fruit that were seen by the writer had all the appearance in leaves, buds, branches, general habits, etc., of hybrids between the apricot and the plum. They are all grafted upon seedling plum stock.

A species of very hardy wild plum occurs in northern Korea and eastern Siberia. It is tall and shrubby in growth, is found in high meadows or among bowlders, and bears large quantities of very sour blue plums of medium size. (S. P. I. Nos. 20073 and 20343.)

CHERRIES.

[CHINESE NAME, "Ying tao'rh."]

The real sweet cherries (*Prunus avium*) do not seem to occur in northern and eastern China, but instead of them they have in the moist, mild-wintered regions of the Yangtze Valley the ordinary Chinese sour cherries (*Prunus pseudo-cerasus*), the fruit of which is rather small and generally sour but very early.

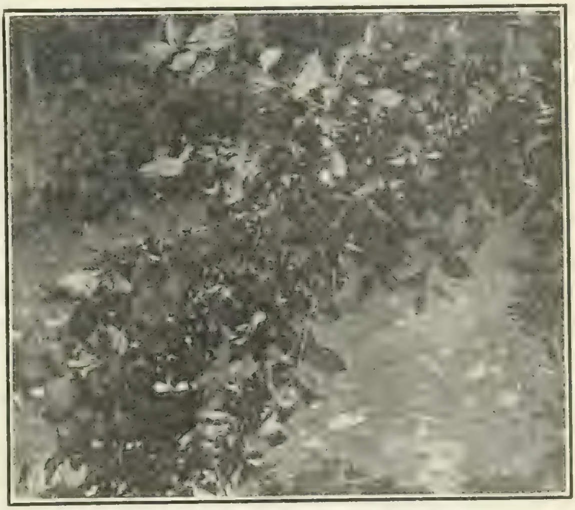

FIG. 8.—A heavily loaded branch of a large-fruited variety of the Chinese "bush cherry" (*Prunus tomentosa*) in a garden in Fongwhangcheng, Manchuria. Introduction Nos. 16918, 17732, 17733, 20075, 20240, 20287, 20288, and 21924.

An example of this earliness is found in the fact that a scion of one of these cherries (a sweet variety) was grafted in the spring of 1906 upon an ordinary Mazzard cherry in the United States Plant Introduction Garden at Chico, Cal., and the following year it bore fruit which was half grown on April 12, at a time when other cherries were just in bloom. (S. P. I. No. 18587.)

The most common cherries in northern China are the "bush cherries" (*Prunus tomentosa*) (fig. 8). These grow wild in the mountains of northern China, Manchuria, and Korea, and are found in dry, rocky places. In a wild state they are densely branched shrubs, bearing very small red fruit; the leaves are very tomentose. When cultivated, however, the plants become less dense in growth, the leaves lose their hairiness to a great extent, and the fruit becomes larger. There are varieties having fruit large enough to be worth consideration as a dessert fruit for localities where our ordinary cherries fail. The Rocky Mountain regions and the regions farther south should be excellent for these bush cherries.

In propagating these plants the Chinese use three methods; i. e., layering, division, and budding upon the wild peach (*Amygdalus davidiana*). The first two methods are but sparingly employed on account of the great difficulties experienced in northern China in transplanting small-rooted plants, either in autumn or in spring, for both seasons are very dry; the last rains fall in September and the first rains often do not come until late in June. They find, therefore, that the best way to multiply these bush cherries is to bud or graft them upon the wild peach, which seems to be a very congenial stock and upon which they make an even faster growth than when left on their own roots.

These Chinese bush cherries prefer a decomposed rocky soil, but do well in almost all other soils when properly cared for. In the garden of Mr. and Mrs. Lykkegaard, of the Danish Mission in Fongwhangcheng, Manchuria, they thrive even under the shade of tall elms, and when seen on June 30, 1906, bore masses of fruit. The preserves which Mrs. Lykkegaard gave the writer to sample were excellent. It is thought that this cherry has a future before it in America. (S. P. I. Nos. 16918, 17732, 17733, 20075, 20240, 20287, 20288, and 21924.)

There is also another cherry sparingly grown in northern China, a small tree or large shrub which has leaves and fruits more like our ordinary cherries, but which grows very dense and seems to be far less hardy than the bush cherries. It is probably the *Prunus pauciflora* of Bunge. It is sparingly cultivated in the neighborhood of Peking, but in the protected mountain valleys of the coast region of the Shantung Province several orchards of it were seen. It is not at all a common fruit tree. (S. P. I. No. 22361.)

There is also a wild dwarf cherry or plum (perhaps *Prunus humilis*) growing in northern China, Manchuria, Korea, and eastern Siberia. The shrubs grow from 1 to 3 feet high, occur on stony and sandy soils, and bear multitudes of scarlet fruits which are generally inedible on account of their sour and acrid properties. Some plants, however, produce slightly sweet fruit that can be eaten raw. The writer never cooked it but thinks that it would make good preserves. This dwarf cherry can very well be used as an ornament in gardens and rockeries. Its greatest value, however, lies in the fact that it can be utilized in breeding experiments. It may also become a fruiting shrub in those regions where fruit growing is now an impossibility. (S. P. I. Nos. 20076, 20085 to 20088 and 20342.)

PEARS.

[CHINESE NAME, "Li."]

CULTIVATED VARIETIES.

Next to the peach, the pear (*Pyrus chinensis*) is probably the most highly appreciated fruit of northern China. Numerous varieties are grown, but not all of them are fit to be introduced into our western lands as acquisitions, for many of them are but seedlings and produce worthless fruit.

The Chinese grow their pears for the greater part on terraced fields and patches in the mountains; but in some regions, as to the south of Peking, where the soil is sandy and is easily blown about, one finds whole orchards of good pears growing upon the plains.

There is a story current among the foreign residents in China that a certain newcomer was asked his opinion of the Chinese pears. "Well," he said, "it depends on what you eat them as; as turnips they are certainly fine, but as pears I would rather not express any opinion." This statement is true so far as the greater number of the Chinese pears is concerned, but there are a few very good ones in China that are well worth cultivation by western people.

The best pear of northern China is, in the opinion of the writer, the quince pear, or, in Chinese, "Ya kwam li." This pear attains a large size, often weighing more than one-half pound; has a somewhat warty, dull-yellow skin, looks and smells like a quince, and has flesh that is mellow, juicy, and aromatic. It is considered so good that it is served upon the tables of foreign hotels in Peking and Tientsin. These pears do not bear rough shipment very well, but when carefully handled they can be kept for the greater part of a year. The trees prefer a sandy soil and are of a spreading habit, so that they require a great deal of space. (S. P. I. Nos. 17724 and 21253.) There is also a smaller variety similar to this, which is not much grown, as the fruit does not bring so good a price as the large variety does. (S. P. I. No. 17725.)

The second-best pear is the so-called "Peking pear," or, in Chinese, "Pai li," meaning white pear. This pear is round like an apple, with a short peduncle, a waxy, yellowish-white color, and has mellow flesh of a sweet flavor, resembling that of our own pears very much. It ripens late and, being a poor keeper, disappears very quickly from the markets. There is some variation in the size of the fruit on different trees. Some are very small, others large, but in general this Pai li is rather a small-sized fruit. (S. P. I. Nos. 16916, 17723, and 22432.)

Another mellow pear of pale-yellow color and of medium size and good flavor is the "Pei soo li," a rare local kind grown in the neighborhood of Jehol. (S. P. I. No. 21928.)

There is also the "Ta suan li," meaning big sour pear, having a very short peduncle and persistent calyx. It is greenish yellow in color. It remains hard until spring, then becomes mellow and has a peculiar, agreeable, sour taste. It is excellent for making into preserves to be used with game or meat. This variety grows near Jehol, China. (S. P. I. No. 21929.)

Then there is the "Mien suan li," or mealy sour pear, which closely resembles the preceding variety and grows near Kwangning, Manchuria. (S. P. I. No. 20260.) Another sour variety, called the "Mo pan suan li," or grindstone sour pear, is similar to the first-mentioned variety. This kind grows in the city of Liaoyang, Manchuria. (S. P. I. No. 20248.)

Another mellow pear, with an agreeable tart flavor, is the "Guarr li," growing at Jehol, China. This variety is rather small, has a short peduncle, is of yellow color, and has a rosy-red blush on one side. (S. P. I. No. 21931.)

Besides all these mellow pears there are a great number of hard pears in China and, strange to say, the Chinese prefer these to the soft ones. The best of all the varieties of hard pears of northern China is the "Ya'rh li." This pear is of large size, of a clear, light-yellow color, has the real pear shape, with a very long peduncle and a nonpersistent calyx. The flesh, although hard, is very juicy and sweet, and foreigners come to like it as much as the natives do. The shipping and keeping qualities of this variety are excellent, and it is to be obtained in northern China throughout the whole winter. There is a good deal of variation in the size and flavor of the fruit, caused by the difference in the trees or by localities, but on the whole this "Ya'rh li" is a fine large pear, well worthy of being introduced. (S. P. I. Nos. 16924, 17178, 17726, 20233, 20234, 20256, 22438, and 22442.)

Another pear, of very large size, ocher-yellow in color, but with coarse flesh, is the "Ma ti huang li," or horseshoe pear. The writer found it growing in gardens in Liaoyang and Kwangning, in Manchuria. (S. P. I. Nos. 20247 and 20251.) Another kind, famous for its fruit, which is dried and put up in boxes, is the "Hsiang sui li," or fragrant water pear. It grows especially well in the city of Liaoyang, Manchuria, and every year a present of a number of boxes of these dried pears is made to the Emperor at Peking.[a] The trees are very vigorous growers, but apparently shy bearers. They can, however, stand a good deal of cold and grow even in and near Kwangchengtze, Manchuria. (S. P. I. Nos. 20232, 20245, and 20253.)

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[a] See Hosie, Alexander, Manchuria.

Near Kwangning, Manchuria, one finds not only this variety but also another, called the "Huang hsiang sui li," or yellow fragrant water pear. (S. P. I. No. 20271.) Then there is the "Mi li," or honey pear, a local variety growing in the Pangshan district, Chihli Province, northern China. It is rather small, egg shaped, with a very long peduncle, a canary-yellow color, a hard flesh, but very juicy and sweet, and is a good keeper. (S. P. I. No. 21912.)

The "Ten li," a rare local variety at Jehol, is of medium size, of a dark canary-yellow color, hard fleshed, but juicy and very sweet. It also is a good keeper. (S. P. I. No. 21930.)

The pears of western Shansi, of the Kwohsien district, are famous for their extraordinary keeping qualities. The "Yoh li," or oil pear (fig. 9), for instance, can be kept for more than a year. This pear is round-oblong in shape, with a long peduncle, is of a straw-yellow color with a reddish cheek, very fragrant, and, although of hard flesh, is very juicy and sweet. These pears are covered with a fatty substance, which perhaps explains their keeping qualities and has given them their name, oil pear. The trees of this variety have a very spreading habit and grow to be very old, even near a century and a half.

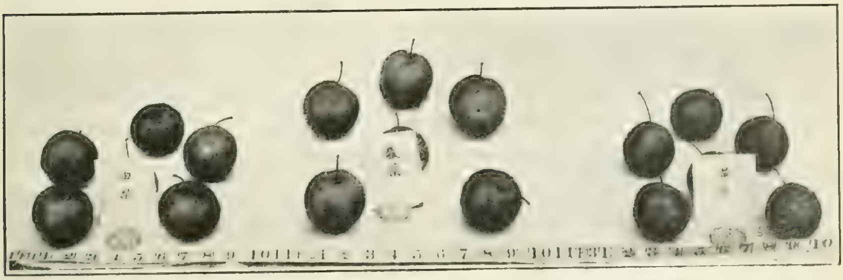

FIG. 9.—The best three varieties of pears of the Kwohsien district, Shansi Province, China. The group to the left is the "Yoh li," or oil pear; that in the center, the "Ben li," or furrowed pear; while the fruits to the extreme right are the "Huang li," or yellow pear.

A second one of these Kwohsien pears is the "Ben li," or furrowed pear (fig. 9). This is of medium size and apple shaped, with a long peduncle. It has four more or less deeply impressed furrows near the peduncle. It is a good keeper, but has not so fine a flavor as the "Yoh li." The trees of this variety grow with semi-erect branches and do not attain as great an age as the preceding variety.

The third good variety of this Kwohsien district is the "Huang li," or yellow pear (fig. 9). It is generally of large size, oblong in shape, with long peduncle, of a pale-yellow color, and fragrant; the flesh, although hard, is very juicy and sweet. It also is a good keeper. The trees have very erect branches.

In the Shantung Province there are some very large pears. The "O li" often weighs 1½ pounds, is green in color, and has hard flesh. The "Siu hua li" is a large yellow pear of the same province. This pear is so flat that the vertical diameter is only one-third of the horizontal, the shape making it look like a curiously flattened apple.

A pear of the Pangshan district, Chihli Province, called the "Ma li," or horse pear, is barrel shaped, with a long peduncle, of pale-straw color, and hard but juicy. It is a very good keeper and shipper. (S. P. I. No. 21914.)

There is a group of red pears in northern China, all of which are apple shaped and remarkable keepers and shippers. One found in the Poliping region, west of Peking, is called "Hong hsau li." (S. P. I. No. 22439.) Then there is the "Hong li," or red pear, of this group. Several varieties of it come from Tongchangdi, Shansi; Pangshan, Chihli; and Kwangning, Manchuria. (S. P. I. Nos. 20257 and 21911.) Another of these red pears is the "Hong bo li," from near Pautingfu, Chihli Province. (S. P. I. No. 22443.) Still another is the "Shui hong hsiau li," from Liaoyang, Manchuria. (S. P. I. No. 20244.)

All these pears are hard fleshed, of medium size, of slightly sour taste, and look so much like apples that one often has to examine them closely to detect the difference. There are also a number of mediocre pears in various places in northern China, like the "Bay li," from Kwangchengtze, the "Kuan hung hsian li," from Kwangning, Manchuria, which, we were informed, is grown only for the Emperor's use, and all the trees of which are known to the magistrate of the district. The "Liu yuea li," from Kwangning, Manchuria, needs to be kept for six months before it acquires the right flavor, while the "Ta yang li," from the same district, needs to be boxed for a month before it is in condition to eat. The "Chin tze li," from Kwangning, Manchuria, is said to have excellent keeping qualities. The "Yuan po li," the "Ta li," the "Yu chin li," the "Chang poa li," the "An li," the "Mien kuan li," the "Chin pai li," the "Ta ma li," the "Ping ding li," the "Ghua kai li," all from Kwangning, Manchuria, and the "Tang li," or russet pear, from the Pangshan district, Chihli Province, and from Kwangning, Manchuria, may be mentioned. The last two pears are apple shaped and have a russet color like the Japanese pears. They are good shippers and keepers, but the flesh is of a coarse texture.

Besides the varieties named there are scores of seedlings in almost every orchard that produce fruit of so little value that they bear no names. As a whole, however, some of these cultivated varieties of Chinese pears will in the future prove to be of very great value to the American fruit growers who will use them for breeding hardier, blight and scale resistant varieties, the more so, as we can point already to our Kieffer, Le Conte, Garber, and some minor varieties which possess Chinese blood in a greater or less degree and which have made pear culture possible in sections of the United States where the European varieties have utterly failed.

WILD PEARS IN NORTHERN CHINA.

There are a few species of wild pears (Pyrus) in northern China which are of great importance to the Chinese and may become so to us. The true Chinese pear (*Pyrus chinensis*) is found growing sparingly in copses in mountain valleys in the Chihli and Shantung provinces. The writer always found these trees as isolated specimens. They are tall trees of open growth and bear small yellow fruit on very long peduncles. The calyx is deciduous. The leaves are few but large, long pointed, and are glossy green above and light green beneath. The trunks have a light-brown color; the bark comes off in strips and the trunks are fairly smooth. This type of tree has probably given rise to the hard-fleshed, yellow-fruited strain of pears, with deciduous calyxes, which is so commonly cultivated in northern China. This group prefers warm, sheltered nooks, and is not found in very cold or exposed localities. (S. P. I. No. 17176.)

There is another type of wild pear quite distinct from that mentioned above. This variety is found on the plains, at the foot of mountains, and here and there on the lower slopes of mountains and hills. It generally grows in clumps and even in large groves. The trees are densely headed and possess spiny branches. The fruit is small and flat, with a very short peduncle and a persistent calyx. It is greenish yellow in color and astringent and inedible before freezing, but after a heavy frost it becomes soft and yellow and has a slightly sour taste. The trees grow to large dimensions in favorable localities. At Shinglungshan, northeast of Peking, there are specimens that grow from 60 to 80 feet high and have trunks from 2 to 3 feet in diameter. The wood has a fine light-brown color and is utilized in the manufacture of printing blocks and wooden combs. The trunks are of a blackish color and, when old, deeply furrowed. This variety, or perhaps species, grows in the colder parts of northern China, in Manchuria, and eastern Siberia, and improved varieties are being grown as far north as Khabarovsk, where the mercury is frozen nearly every winter.

This species of pear has given rise, in all probability, to the mellow-fleshed pears of northern China; if not to all of them, certainly to the "Ta suan li," the "Mo pan suan li," and the "Guarr li," all three of which resemble very closely the wild type. (S. P. I. Nos. 17177, 19604, 20243, 20267, 20336, 20337, 21880, 21918, and 21923.)

Another type of pear, called the "Tang li," grows wild here and there in the Shantung Province. In characteristics it stands midway between the two last-mentioned species. The trees are found as isolated specimens and look very much like the real *Pyrus chinensis*, but are of denser growth and have large, beautiful, glossy leaves, while the fruits are rather large, have medium-long peduncles and persistent calyxes, and are mealy when ripe. Their color is a rusty brown. A small group of pears, the "Tang li" group, has probably been derived from this strain of wild pears. (S. P. I. No. 21983.)

The last in the list of the wild pears in northern China is the *Pyrus betulaefolia*, or "Doh li." The fruit of this pear does not grow any larger than a good-sized green pea. It hangs in bunches, covering the whole tree, is brown in color, and does not become soft and edible until late in the fall. The trees generally do not grow very tall, but form extraordinarily dense heads of branches. One often finds well-developed specimens growing on the alkaline or sandy plains. They thrive equally well on cliffs and along streams, but they are then of a more shrubby nature. This pear is extensively used as a stock for cultivated varieties in those parts of northern China where the winter is not too severe. It stands alkali wonderfully well and will grow even in pure sand.

The Chinese claim that this pear is far easier to grow from cuttings than to raise from seed. I can not vouch for this statement, but I know that the people apparently always have some stock on hand, though it has often a wonderfully straggling habit. This pear may be of use to us as a shade and ornamental tree, being covered in the spring with an amazing quantity of flowers, followed by a multitude of small fruits, which hide among the dense mass of foliage. (S. P. I. Nos. 17727 and 21982.)

APPLES.

[Chinese name, "Ping kua."]

CULTIVATED VARIETIES.

The apples (*Malus* spp.) of China are very inferior in flavor to the western kinds. In fact, the true apple, *Malus sylvestris*, does not do very well in eastern China, and beyond a few specimens in the gardens of foreign residents it seems to be unknown to the Chinese. In the Shantung Province and in some parts of Mongolia there are said to be native apples of superior flavor, but I never had the good fortune to come across them, unless it were some apples I tasted in the garden of the late Doctor Nevius, an American missionary in Chefoo, who introduced many kinds of western fruits into China.

The larger, whitish varieties of apples which the Chinese cultivate seem to belong to the *Malus prunifolia* group. The trees have a wide-branching growth; the leaves are tomentose, ovate, with rounded ends and long petioles. The fruit though often attractive in appearance is soft, spongy in texture, and insipid in flavor. The trees do not grow in very cold and exposed regions and do not seem to be able to stand much drought.

Belonging to this group is the "Pai ping kua," or white apple, from the environs of Peking and Pautingfu. The fruit varies a good deal in size. It is much used for preserves. (S. P. I. Nos. 22371 and 22440.) Mention may be made of the "Hong teng ku," or red apple, from near Pautingfu (S. P. I. No. 22372), the "Sha hoa tze," a medium-sized apple of whitish color, with red cheeks, from Kwangchengtze, Manchuria (S. P. I. No. 20230), the "Ping kua" (S. P. I. No. 20280), and the "Pin tze" (S. P. I. No. 20277), from Kwangning, Manchuria, and the "Sa kua," from the Pangshan district, northern China, and Kwangning, Manchuria. The last is a flat apple, like the saucer peach. It has an insipid flavor and does not keep well. (S. P. I. Nos. 20276 and 21915.) The "Ly tze" is a sour red apple, also of a flat saucer-peach shape and a poor keeper. It is from the Pangshan district. (S. P. I. No. 21916.)

There is another group of apples in China, the trees of which are of large growth, the branches erect, the leaves pointed, very little tomentose, or even glossy. The fruit is small, mostly of a red color, and though often mealy is generally sour in flavor. This group stands more cold, drought, and privation than the first class. The trees thrive as far north as Khabarovsk, on the forty-fourth parallel of latitude. In all probability they have been derived by selection and perhaps hybridization from the wild crab apple (*Malus baccata*), which is abundant all over northern China, Manchuria, northern Korea, and eastern Siberia.

To this group belong the "Hua hong," a large red crab apple growing in Kwangchengtze, Manchuria (S. P. I. No. 20231), the "Gai tang," the fruit of which is as large as a good-sized cherry, dark red in color, with a bluish blush, and growing near Jehol, northern China (S. P. I. Nos. 21879 and 21927), and a variety called by the Russians "Reinetka," growing vigorously in Khabarovsk, Siberia, and probably the same as the "Hua hong." (S. P. I. No. 19603.)

THE WILD CRAB APPLE.

The Chinese in northern China and Manchuria and the Russians in Siberia graft all their apples on the Siberian crab apple (*Malus baccata*), which, as stated before, grows wild all over northeastern Asia. There is great variability in the size of the tree. Sometimes one finds a specimen on an exposed, dry mountain side, in appearance like a gnarled shrub, but bearing an abundance of fruit. Again, in good fertile spots one may see it as a tall tree from 40 to 50 feet high and having a trunk a couple of feet in diameter. The productivity of these wild crabs is something marvelous. The little apples, about the size of small green peas, are eagerly collected by the Russians and the Chinese and are either eaten fresh, dried, or made into preserves.

From what the writer has seen of the hardships this wild crab apple is able to stand in its native haunts, it would seem that there are few places in the northern portions of the United States where it would not succeed. Even if it is not suitable as a fruit tree it is a fine ornamental plant, both when in bloom and when loaded with its thousands of little scarlet fruits. (S. P. I. Nos. 20137, 20237, 20238, 20339 to 20341, 21065, 21878, and 21922.)

QUINCES.

The quince (*Cydonia* sp.) most often seen for sale on fruit stands in China is the true Chinese quince, *Cydonia sinensis*, or in the native vernacular, "Mu kua." The trees are by no means common throughout northern China. One has to travel to central Shantung before finding them growing even sparingly in gardens, and it is only farther south that they are cultivated on a large scale for shipment. The fruit grows to an exceedingly large size, being sometimes even a foot long and weighing 10 pounds apiece. It is never eaten by the people of northern China, but is used by them exclusively for perfuming their rooms. The well-to-do classes have in the winter time a large bowl filled with the fruit and placed upon a table in a cool room, so that it perfumes the whole atmosphere with a delightful spicy aroma. Foreign residents, however, have found that these quinces make excellent sweetmeats, and they preserve them in various ways. The writer has tasted jellies and jams made from them that were unexcelled for fine, aromatic flavor. (S. P. I. No. 17954, under *Cydonia japonica.*)

There is also a variety of the Japan quince (*Cydonia japonica*, S. P. I. No. 22581) cultivated sparingly in the mountains near Peking. The fruit is small, of a greenish color, covered with a brown bloom, and very fragrant. It is called "Pei mu kua," and is also used for perfuming rooms, but mostly by the poorer classes, it being very much cheaper than the Chinese quince.

Another variety of the Japan quince is called "Mu li." Its fruit is larger than that of the preceding one, has a very spicy odor, and is used for the same purpose as the first two. (S. P. I. Nos. 18601 and 22629.)

In the Shantung Province there were also observed in a few temple yards cydonias that grow to be tall trees, from 30 to 40 feet in height, with a very smooth bark that comes off in strips. The leaves are round-oblong, serrated, with very short petioles, glossy, dark green above and light green underneath. The fruit looks like the European quince. It is very woody and not edible, but it possesses a pleasing, spicy odor. The writer noticed two other varieties, one having round fruit and called "Hsau kua shu" (S. P. I. No. 21984), the other with oblong fruit, the "Mu li shu."

Here and there in central China, as in Hangchow and Soochow, the Chinese cultivate in earthen vessels a very uncommon dwarf form of *Cydonia japonica* var. *maulei*. It is called the "Lo hai tang," and seems to be used for ornamental purposes only. (S. P. I. No. 22984.)

HAWS.

[Chinese names, "Hong kua," "Suan dzao," and "San li hong."]

In northern China there are whole orchards of an edible haw (*Crataegus pinnatifida*). These trees have all been grafted. They are carefully cultivated and the fruit is harvested and shipped all over the land, very much, in fact, as apples are with us. (See fig. 10.) The fruit is of a bright-red color, fairly hard, and of an agreeable sour taste. There is considerable variation in the size of the fruit and its acidity, but the best kinds are as large as good-sized crab apples and are only slightly acid.

Haw fruits are extensively used in the manufacture of sweetmeats and preserves, and foreigners and natives are equally fond of them. In the foreign embassies in Peking one is served with cake that has preserved haw fruit as a filling. Foreign missionaries supply visitors with a kind of haw jelly, and the Chinese give a jar of haw preserves as a New Year's present. The fruit of a rather sour, dry-meated variety is sliced and dried and kept for winter use. In this form it is called "Suan dza." The Chinese make much use of it during the winter months for brewing a tea which they claim acts as a blood and system purifier. This dried fruit can also be stewed, and by the addition of sugar it makes a good compote, tasting not unlike apple preserve. It is one of the fruits that can be safely introduced into America and will not have to wait long to become popular.

Aside from its fruit it is a very handsome, ornamental tree, making a dense head of dark-green foliage, turning into gorgeous red and yellow in the fall. The height rarely exceeds 30 feet, and some varieties branch out almost at the ground, thus making them well suited for ornamental trees on lawns. (S. P. I. Nos. 17171, 17739, 17882, 17883, and 19405.)

The largest and best haw fruit comes from the Shantung Province. It is especially in the neighborhood of Taianfu that one finds remarkably large-fruited varieties, the trees of which are very productive.

There are many seedlings of this haw in cultivation which in general bear but small fruits, and these smaller ones are nearly always more acid than the larger varieties. This is an advantage in one way, for this acidity makes them an excellent substitute for cranberries, a fact which the American missionaries in the Shantung Province have learned to their advantage. Since this haw is a very hardy tree and can stand considerable drought and heat its fruit might take the place of cranberries in sections of the United States where the latter are hard to obtain at the present time, as anyone could grow one or two of these trees to supply his own wants. (S. P. I. No. 21987.)

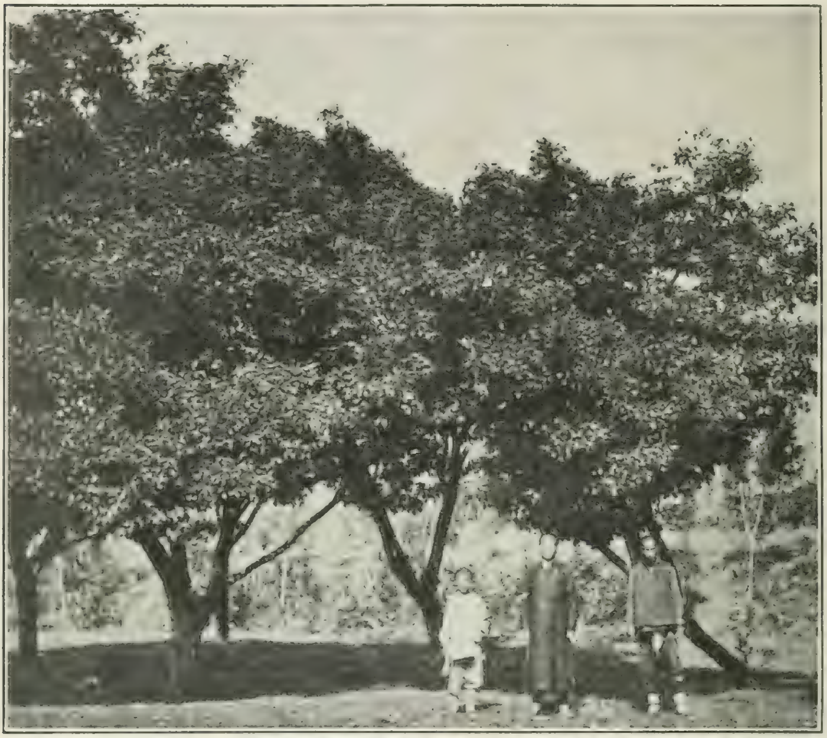

FIG. 10.—A group of trees of a large-fruited variety of the Chinese haw (*Crataegus pinnatifida*) near Changli, Chihli Province, China. The fruit of this variety is extensively employed in the preparation of marmalade and jelly. Introduction No. 17882.

The stock upon which the Chinese graft their large-fruited varieties is the wild *Crataegus pinnatifida*, growing in many places in the mountains in northern China, Manchuria, northern Korea, and eastern Siberia. It is mostly seen as a shrub. In favorable locations, however, it grows into a small tree. In general, the wild tree or shrub is well furnished with long thorns, while the large-fruited cultivated trees are entirely without them.

Even in the wild state there is a good deal of variation in the appearance and behavior of the plants. Some specimens have very small leaves and are heavy fruiters; others, again, are very large leaved and bear few fruits, etc., but they all seem able to stand drought, cold, and adverse conditions to an unusual degree, and they therefore hold out great promise as to their future behavior in the United States. (S. P. I. Nos. 17170, 17751, 20108, 20109, 20350, 21921, and 22607.)

LOQUATS.

[Chinese name, "Bibaw."]

The loquat (*Eriobotrya japonica*) is in all probability indigenous to the hills of the mild-wintered, moist regions of central-eastern China. The writer observed some specimens growing wild among the scrub in the region near Tangsi, Chekiang Province. That section is one of the most noted loquat regions of China. As far as the eye can see one observes nothing but loquat orchards, growing luxuriantly on the low, rich land, where the roots never suffer from lack of water.

There are several varieties of loquats in cultivation, differing a good deal in flavor, color, and quality. The finest kind is considered to be the white loquat, the fruit of which is said to be of a pale-yellowish color and of a very fine flavor. It is called in Chinese "Pai bibaw," or white loquat. (S. P. I. No. 22976.)

The different varieties are all grafted on seedling stock; but as the Chinese are not always very successful with their grafting, they generally lose a large percentage of them, and thrifty young plants are exceedingly hard to obtain.

The Chinese consider the loquat a very profitable tree, although apparently it bears a good crop only every two or three years. Rev. Alexander Kennedy, a missionary in Tangsi, who assisted us a great deal in obtaining various plants, stated that in the spring of 1906 the loquat crop was so great in his vicinity that from the village of Tangsi, alone, twenty thousand dollars' worth of fruit was exported.

JUJUBES.

[Chinese name, "Tsao."]

CULTIVATED VARIETIES.

The jujube (*Zizyphus sativa*) is quite an important fruit in northern China, grown everywhere in those sections where winter temperatures are not too low. The trees can stand a remarkable amount of neglect without any apparent detriment. They are found equally productive on a piece of strongly alkaline land or in an inner courtyard where the ground has been tramped down until it is as hard as stone. (See Pl. V, fig. 2.)

The soil best suited to this fruit seems to be a porous clay, charged with more or less alkaline matter, like the loess in northern China. The jujube also thrives better in regions where the rainfall is rather light and the winters dry and cold than in moist, mild-wintered sections.

In general, jujubes are grown in small groves or as single trees, but here and there one also meets regular orchards of them, covering perhaps 10 or 20 acres. In some localities the farmers plant them in rows through the fields. It seems that planted in this way, at a distance of from 5 to 10 feet apart, they produce the largest quantity and the best quality of fruit. When in regular orchards the distance apart is from 15 to 25 feet, depending upon the variety and upon the personal preference of the planter.

The farmers, here and there, also have the habit of ringing their trees every year, claiming that thereby they considerably increase the crop. (See Pl. VI, fig. 2.) The jujube is about the only fruit tree around the roots of which the soil is not regularly cultivated, because the yield is found to be just as large without this work as with it.

There are a great many varieties of the jujube in cultivation, probably not less than a hundred, varying in size, color, shape, quality, etc. As the varieties do not come true to seed, the trees are mostly propagated by the suckers which are nearly always found at their bases. Root cuttings can also be taken. Some varieties, however, do not readily produce suckers, and root cuttings are not successful. Then the Chinese resort to grafting the scions on wild stock. This grafting practice, however, seems to be confined to only a few localities, where the growers are men of considerable experience.

The fruit of these jujubes is nearly all of a shining brown color and is very plump when fresh. When dried it has more of a red color and becomes shriveled. It is eaten fresh, dried, preserved in sugar, stewed, or smoked. Some varieties are better for one purpose, others for another.

The different varieties that came under the writer's notice are enumerated as follows:

"Ming tsao," a rather large-fruited variety, growing near Peking and Jehol, China. The fruit is of a light brown-red color, from 1¼ to 1½ inches long, of oblong shape, and quite sweet. The trees remain small, grow very erect, occupy but little space, and are almost devoid of spines. They sucker and spread very rapidly when young.

"Ya tsao," growing near Jehol, China. The fruit is large, from 1½ to 2 inches long, tapering toward the peduncle, of a dark brown-red color, and not very sweet. The trees remain small, grow fairly erect, but are very spiny, and sucker and spread freely.

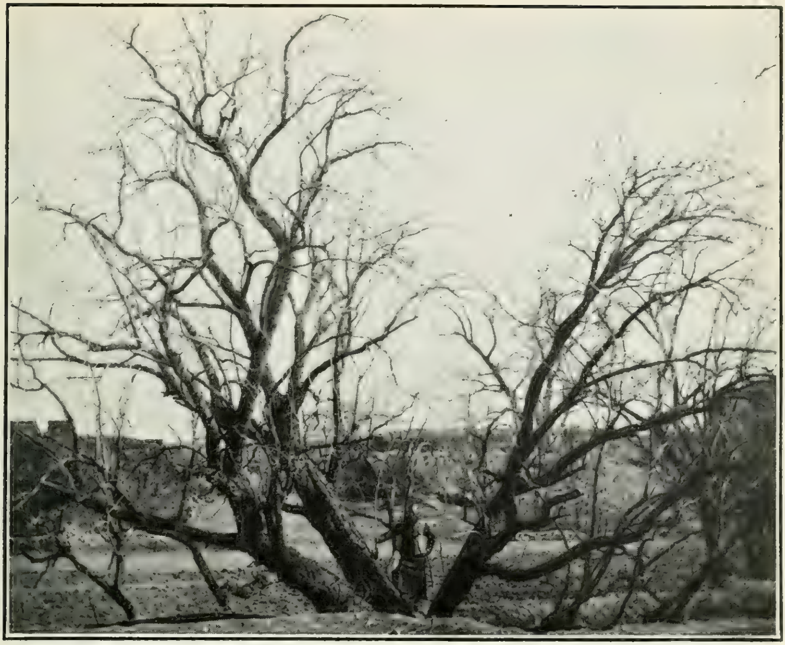

FIG. 1.—AN OLD SPECIMEN OF THE "LANG TSAO," OR MELLOW JUJUBE, AT TSINTZE, SHANSI PROVINCE, CHINA, SHOWING THE PECULIAR HABIT OF GROWTH CHARACTERISTIC OF THIS VARIETY.

Introduction No. 22686.

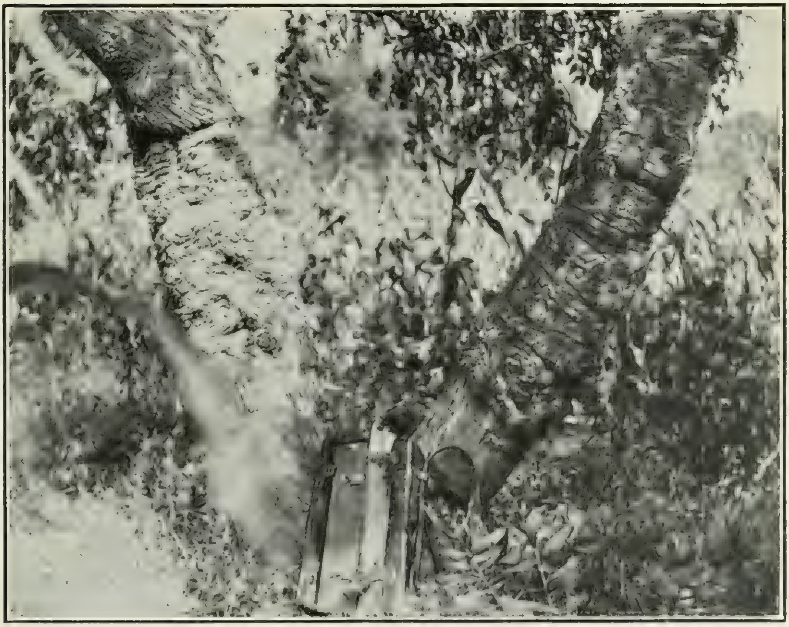

FIG. 2.—A NEAR VIEW OF THE TRUNK OF A CHINESE SEEDLESS JUJUBE TREE NEAR LAOLING, SHANTUNG PROVINCE, CHINA, SHOWING THE RINGS THAT HAVE BEEN MADE EACH YEAR BY SAWING THROUGH THE BARK TO MAKE THE TREES BEAR MORE HEAVILY.

"Mu shing hong tsao," growing at Tsintze, Shansi. The fruit is of a red-brown color, of medium size, oblong, tapering toward the apex, and can be kept a long time. The trees grow to a large size and become very old. (See Pl. IV, fig. 2.) When old they are very little branched, have no spines, and sucker but little. (S. P. I. No. 22684.)

"Hu ping tsao," meaning bottle jujube, growing in Tsintze, Shansi. The fruit is large, oblong, and of a shining red color. It is usually eaten after having been soaked a couple of months in weak Chinese spirits. This variety is considered locally as the best grown. The trees do not reach a large size, are planted close together, from 6 to 8 feet apart, are spineless, and sucker but little. (S. P. I. No. 22683.)

"Tsui ling tsao," meaning fragile jujube, growing in Tsintze, Shansi. The fruit is oblong, of red color, is said to break easily on falling, whence its name, and is a poor keeper. The trees grow to medium size, are spineless, and sucker but little. (S. P. I. No. 22685.)

"Lang tsao," or mellow jujube, growing in Tsintze, Shansi. The fruit is small, oblong, red colored, and of a mellow, sweet flavor. It can not be kept long. The trees grow large and spread out very much, behaving quite differently in this respect from other varieties. (See Pl. VI, fig. 1.) (S. P. I. No. 22686.)

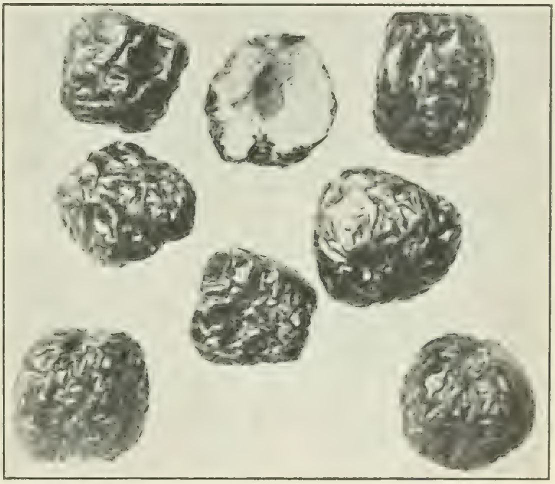

FIG. 11.—Chinese smoked jujubes. The jujubes of this variety are called "Yuen ling tsao" or "Su hsin tsao" when fresh, but go under the name of "Ghac tsao" when smoked. They are largely shipped to southern China, where they find a ready market.

"Yuen ling tsao" or "Su hsin tsao," a round-fruited variety of dark brown-red color, found near Hweigörr, Shantung. Its fruit is smoked and exported in large quantities to southern China, where there is a great demand for smoked jujubes (fig. 11).

"Wuhu tsao," or seedless jujube, growing near Laoling, Shantung. This variety is said to be the only seedless variety in the whole Chinese Empire and is sent every year as a present to the Emperor at Peking. It has made the Wuhu magistracy, where it grows, famous all over China for its jujubes. The fruit is not absolutely seedless, but the kernel is so soft that it is practically imperceptible when eaten and the fruit may therefore safely be called seedless. The fruits are rather small, of a dark brown-red color, and very sweet. They are excellent when boiled with rice or millet, make delicious stewed compote, and can be eaten dried with peanuts, the same as raisins and almonds. Foreign soldiers in Peking, with whom the writer tested a few pounds, were remarkably fond of them.

The trees grow only to a medium size. They are usually planted in rows through the fields at distances of from 8 to 10 feet apart. The Chinese ring the trees every year at the time of the setting of the fruit by sawing through the bark close to the base of the trunk. They say that if this is not done half of the fruit is thrown off by the tree, so that by this method they double the crop. (See Pl. VI, fig. 2.) The fruit of the ringed trees, however, is not so sweet by far as that coming from the unringed trees.

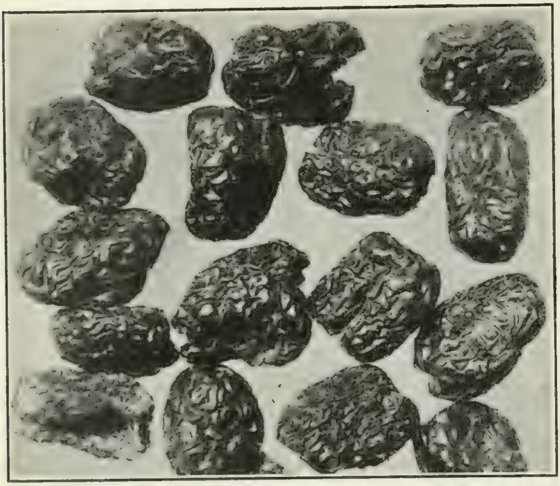

FIG. 12.—Chinese jujubes of the "Chin sze tsao" variety, used extensively in the manufacture of the so-called honey jujubes ("Mi tsao"). A remarkably sweet variety.

"Chin sze tsao," a rather small but very sweet variety, growing at Laoling, Shantung (fig. 12). This variety is said to be one of the best for the manufacture of the celebrated honey jujubes. The fruit is of a light brown-red color; the trees are of medium size, with much of the habit of the seedless jujube.

"Tun ku yu tsao," a flat jujube, growing near Chinanfu, Shantung. This variety has a dark-brown color and is remarkably sweet; considered locally one of the best varieties for eating fresh.

"Twen ku lu tsao," another flat variety, growing near Chingchowfu, Shantung. The fruit is of medium-large size, of dark-brown color, and is also very sweet. It does not keep long. The trees are of medium growth, bear but little fruit, and sucker very little. They are propagated by being grafted upon the wild stock.

Besides the varieties mentioned there are scores of others that did not come under the writer's personal observation, but which are mentioned in various Chinese publications. One variety is even said to be white.

There is an article often served to foreigners in China in homes and in hotels looking strikingly like the Persian date. This is the celebrated "Mi tsao," or honey jujube (figs. 13 and 14). To prepare this the Chinese take large, sound, dried fruits and boil them thoroughly in sugared water, after which they are taken out and dried in the sun or wind for a couple of days. When sufficiently dry they are given a slight boiling again and are partly dried. When dry enough to be handled, the skin is slightly slashed lengthwise with a few small knives tied together. Then the fruits are given a third boiling, now, however, in a stronger sugar water, and for the best grades of honey jujube honey is added. When this process is finished they are spread out to dry, and when no longer sticky are ready to be sold. The best grade of these honey jujubes sells for 40 cents Mexican a pound, and is obtainable in only a few of the larger cities of China. In case the American people should take to growing the jujube, they would find a ready market for the better varieties for use in the manufacture of various confections.

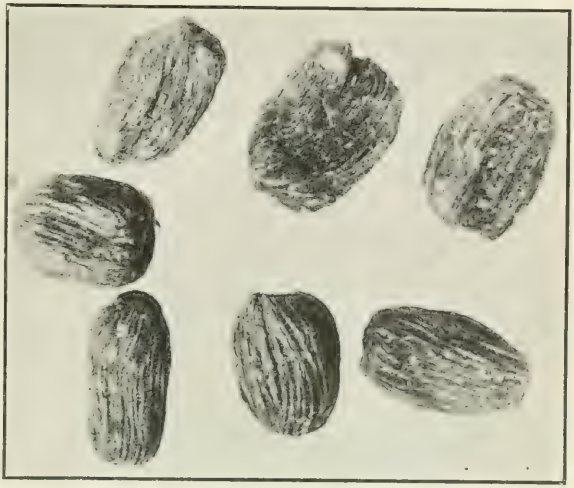

FIG. 13.—Small honey jujubes, not as high priced as those shown in figure 14, though of as good, if not better, flavor.

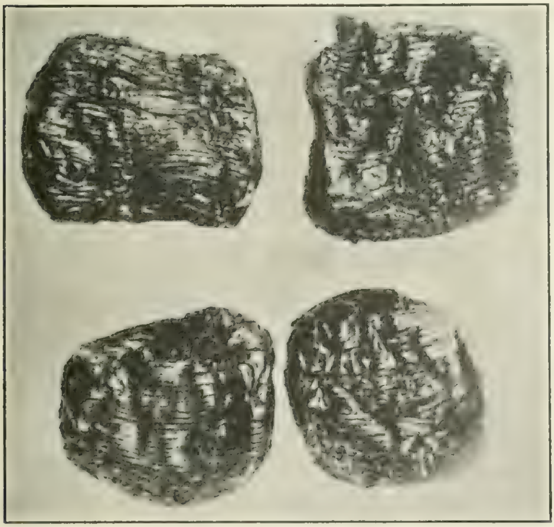

FIG. 14.—The best of the Chinese honey jujubes. These are excellent candied fruits which deserve to become well known in America. The trees withstand considerable alkali and drought.

DRAGON'S-CLAW JUJUBE.

With so many varieties of jujubes in cultivation it is not surprising that one kind has been produced that has an ornamental value. This is the quaint "dragon's-claw" jujube (*Zizyphus sativa tortuosa*) or, in Chinese, the "Lung tsao tsao shu." This variety has peculiar gnarled and twisted branches and is very rare. The rich Chinese prize them highly as horticultural curiosities. The trees are propagated by being grafted on the wild jubube. (S. P. I. No. 22914.)

THE WILD JUJUBE.

Finally we come to the original wild jujube (*Zizyphus sativa spinosa*) from which the cultivated varieties have been derived. This species grows wild on most of the walls of the northern China cities, and is also to be found in the most out of the way, stony, and sterile locations. It has ugly hooked spines, which easily tear one's clothes and break off in one's flesh. The fruit is small and round, of a brown-red color, and has a pleasant sour taste. It is collected by old women and children, and an inferior paste and preserve are made from it. The very spiny branches are used as fencing material and keep intruders away by their forbidding appearance. In general, this wild jujube grows only as a bush; but when left alone in favorable locations it reaches the size of a tree from 20 to 30 feet high, with a trunk more than a foot in diameter. It becomes less spiny when large; but it is still far from easy to climb one of these trees without the loss of some blood. (S. P. I. Nos. 17892 and 21995.)

GRAPES.

[CHINESE NAME, "Poo tao."]

CULTIVATED VARIETIES.

The grape is as much esteemed by the Chinese as by western nations. *Vitis vinifera* is not a native of China, but was introduced there from central Asia by the Emperor Wu ti, who in the first century before our era sent ten envoys to various countries west of China, who brought back grapes and alfalfa.[a]

How many varieties of grapes were originally introduced it would be hard to ascertain, but there must have been several, for at present a good many varieties are being grown in northern China.

There is a very fine white variety cultivated near Changli, having round berries and possessing a good flavor. It ripens in the latter part of September (S. P. I. No. 17155). Another white kind occurs near Hsuenhuafu. This variety is the highest priced of all the Chinese grapes and is to be had only in limited quantities. The bunches are rather large, the berries much elongated, and the flavor is sweet and refreshing. It is a good keeper, the fruit being kept in paper-lined baskets or in jars in cool places until February (S. P. I. Nos. 16927 and 17156). There are also some seedless white grapes in northern China, one variety being apparently the same as the Sultanina, or so-called Thompson Seedless. (S. P. I. No. 17160.)

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[a] Sampson, Theo. Grapes in China. Notes and Queries on China and Japan, April, 1869, p. 50.

There are also several varieties of purple grapes, central Shansi, especially, being renowned for them. One variety can be kept for almost a whole year if the fruit is carefully put in baskets and jars and kept in cellars which are cooled by ice.

The culture of grapes in China is somewhat different from what it is in other lands. The plants are always grown trained over arbors, with very long main leaders. In the month of October, just after a cold snap, the vines are taken from their supports, skillfully pruned, and then tied together in long bundles. If the main leaders are very long they are bent around to make the bundle shorter. Pits from 4 to 6 feet deep are dug, wide enough for a man to work comfortably in and as long as the tied-up bundle of the grapevine requires. The vines are now laid down in these pits, which are covered with sorghum stems and old matting, over which a couple of feet of soil is put (fig. 15). Care is always taken to leave a few air holes, which are left open in warm weather but are closed up entirely in case a blizzard occurs. The root from which the stems originate is never taken up, but some old matting is put around it and the whole is covered with soil to the depth of a few feet.

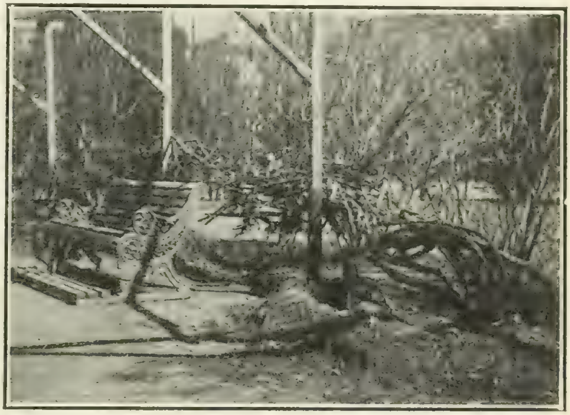

Fig. 15.—A grapevine of a tender variety just removed from a trench where it was protected for five months. Photographed March 31, at Tientsin, China.

In visiting a vineyard in China in the winter, unless one's attention were drawn to it, few people would suppose that the apparently barren spot they were walking upon was covered in summer with a luxuriant growth of choice grapes. This practice of burying the grapevines that would not be able to pass unprotected through severe winters is certainly worthy of general attention. It can not be done in the United States on a large scale, as the high price of American labor would be prohibitive, but in the Rocky Mountain section of the United States, especially, the people could have choice varieties of grapes for their own table use if they would take the trouble to protect the vines in winter in this way.[a]

RAISINS.

Raisins are not common in China, and those seen there are a small, seedless, greenish-white kind, said to be made from grapes grown in the neighborhood of Kweihuacheng, Mongolia, a district with very dry air.

VARIOUS SPECIES OF WILD GRAPES.

[Chinese name, Shan poo tao.]

In northern China, Manchuria, and eastern Siberia a wild grape (*Vitis amurensis*) grows. This grape is found in dense thickets overrunning shrubs and trees. It is a rather prolific bearer, the bunches and berries being small, however, and rather sour; but the plant is so remarkably hardy, standing temperatures of −40° F., that there may be a possibility of using it in hybridization experiments. In its wild state it is collected by the Chinese and Russians and eagerly eaten. In eastern Siberia the writer also tasted some inferior wine and some good vinegar that had been made from it by a Russian settler. (S. P. I. Nos. 19477, 19600, 20347 to 20349, and 22601.)

Besides the *Vitus amurensis*, one finds here and there various other wild species. In the Boshan district is found a wild grape called "Ya pu tao" (S. P. I. No. 21979). From it the Chinese make a fairly good wine, which is remarkably strong. In the Lungtung district of Shantung there are two other species, both bearing edible berries. In the Mokansan region, to the southwest of Shanghai, one finds grapes that have many spines along their branches and bear edible berries. They are even sparingly cultivated by foreigners. In all probability they are a species of Spinovitis (perhaps *S. davidi*) and might be fitted for hybridizing with better varieties to produce strains of grapes that could stand a greater degree of moist heat than our present good varieties are able to do.

THE CITRUS GROUP.

Numerous, indeed, are the various species and varieties of Citrus in China. As is well known, southern China is supposed to be the home of the sweet orange (*Citrus aurantium sinensis*). Besides this species, mandarins and tangerines (*C. nobilis*) and kumquats (*C. japonica*) are in all probability natives of China, the last two probably coming from the mild, equable climate of south-central China. In the vicinity of Hangchow wild pomelos occur, while in Shensi and Shantung *Citrus trifoliata* is found in a wild state.

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[a] This method is practiced to a limited extent with tender varieties in the Northern States and in Canada.—William A. Taylor.

There are said to be more than 80 different kinds of edible oranges growing along the southeastern coast of China and on the numerous islands fringing that coast. A few that came under the writer's notice are as follows:

SWEET ORANGES.

There are several varieties of the sweet orange (*Citrus aurantium sinensis*) in China. They appear on the markets in winter and are chiefly from southern China. One variety, said to grow near Canton, is of medium size and very sweet. It is especially in favor with the foreign residents. Blood-red oranges of this type are also occasionally seen.

MANDARINS.

Under mandarins (*Citrus nobilis*) we may group the large flat fruits with a loose, generally dark orange-red skin. The trees need rather high temperatures to thrive. The leaves and wood are of a much stronger growth and are very much darker colored than those of the tangerines. The trees are not so prolific. The Chinese possess some excellent varieties of mandarins. One very large one is perfectly seedless and very sweet. It grows especially well on the islands off the coast between Foochow and Amoy. Some excellent varieties are also found in the Szechwan Province and above Ichang on the Yangtze River. To the same group belong the so-called bitter or tonic oranges from Wenchow, Chekiang Province. This fruit possesses a bitter flavor that makes it very acceptable on the breakfast table, it having tonic properties similar to those of the pomelo.

TANGERINES.

Under tangerines (*Citrus nobilis*) are placed the small loose-skinned varieties, mostly of a light orange color and generally quite well supplied with seeds. The leaves are small and of a light green color. The branches, although thin and long, are closely massed, thus making the trees very dense and round headed. The trees seem to be able to stand a considerable degree of cold. There are several varieties, differing much in size and flavor. One rather small variety is grown extensively near Hangchow in the Chekiang Province. When these groves were visited in the spring of 1906 many trees were completely bent down and a good many limbs had been broken off by a

10-inch snowfall two days before, but although the trees had been shattered by the snow they had not suffered at all from the cold.

KUMQUATS.

The kumquat (*Citrus japonica*) is a small fruit which is very much appreciated in China. All who have ever had a good Chinese dinner know how this fruit is served, preserved in sugar or sirup. It is worthy of being more widely known by the western nations than it is at present. There are a few varieties of this fruit cultivated by the Chinese differing in size and shape. The elongated form, however, seems to be the most highly appreciated and is found in the fall of the year in all the markets and fruit stands, being sent even as far north as Peking.

POMELOS AND SHADDOCKS.

Several varieties of pomelos and shaddocks (*Citrus decumana*) are found in China. The orchards, however, exist near Amoy and Canton and the writer never saw any trees except some dwarfed ones in nurseries. The fruits themselves are plentiful in Shanghai, being served even on the tables of the foreign hotels. One variety of pomelo is particularly good and is called by foreigners the "Amoy" pomelo. It is of a flat shape, has a loose skin, and its segments separate as easily as those of an orange. It has a sweet flavor and when it is fresh the fruit is quite juicy, differing from some other kinds that are extremely dry, even when not old. This class of sweet pomelos, the segments of which separate easily, is never served as a breakfast fruit but is eaten as a dessert, served in segments. Coming after the oranges have gone, this variety fills a decided gap in dessert fruits on the tables of people living in the Far East. (S. P. I. Nos. 21870 and 25506.)

LEMONS.

In China the lemon is apparently not grown as a fruit tree, for lemons are rather scarce and expensive, being imported from outside countries. In Peking and Tientsin the price of lemons in winter is sometimes as high as 20 cents in our money apiece.

As an ornamental plant, however, lemons are very much appreciated as dwarfed pot plants. The idea is to have as many fruits as possible on the smallest possible plant. A plant with a dozen or more fruits on it will sell in Peking in the winter for as much as $10. The particular variety used for this purpose slips easily and is raised from cuttings. The fruit is large, very smooth, and thin skinned, very juicy, only slightly sour, and is practically seedless. (S. P. I. Nos. 21905 and 23028.)

FINGERED LEMONS.

The fingered lemon, or "Buddha's hand" (*Citrus medica digitata*), is a queer fruit largely grown by the well-to-do Chinese as an ornamental pot plant. The strange fruits are greatly prized by the people as presents and as religious objects. They are supposed to bring good luck to the household. Indeed, so highly are they valued that in the north a good sound fruit sells for one Mexican dollar.

NOVEL CITRUS FRUITS.

In Peking one can sometimes buy in the winter some strange orange-like fruits. They have the appearance of a warty Satsuma orange, but the flesh is fibrous, sour, bitter, and not edible. They are used as room perfumes, like quinces. (S. P. I. No. 21904.)

In the neighborhood of Hangchow there is a peculiar citrus fruit growing wild upon the hillsides. The fruit is very large, 4 inches long by 2½ to 3 inches in width. The skin is of a dark yellow color, thick but loose, and contains a peculiarly pungent volatile oil. The pulp is of a refreshing sour flavor, between that of a lemon and a pomelo; in fact, it serves as a lemon for foreigners in that part of China. It is full of large flat seeds, resembling those of the pomelo. The trees grow straight and tall, are rather bare branched, and are furnished with large spines. They are capable of standing severe frosts and heavy snowfalls without being hurt, and might therefore be utilized as stock in the United States. The Chinese names for this fruit are "Schu yu" and "Ning bon." (S. P. I. No. 18439.)

Besides the citrus fruits mentioned, the Chinese cultivate several others, some of which the writer was not able to see in fruit. In some small nurseries one often finds twenty or more citrus varieties, all grown in pots and vessels as dwarfed specimens. Some are slipped, others have been layered, some are grafted upon *Citrus trifoliata*, others, again, on seedling stock of some kind or other. They are all in great favor as pot plants and there is much demand for them.

NAGIS.

[Chinese name, "Yang mae."]

The nagi (*Myrica nagi*) thrives to perfection on the slopes of the hills in the Chekiang Province. It also occurs on the Chusan Islands and in other places in southeastern China. It prefers a well-drained situation, and where found wild it often grows in rather poor, rocky soils, in semishady localities. The wild shrubs or small trees grow very straggling and open. In cultivation, however, where they get full sunlight and proper care, they grow dense and bushy and are very ornamental, especially in early summer, when the masses of carmine fruit contrast beautifully with the glossy light-green foliage.

Several varieties are cultivated in China, varying in color from dull white, yellowish red, rosy red, and carmine to black red; in size, from a cherry up to a medium-sized plum; and in flavor, from very acid to refreshingly sweet. The best varieties are grafted upon wild or seedling stock, but it is no very easy undertaking to do this. The trees can be transplanted only with the greatest difficulty, and for that reason plantations extend but very slowly. Wherever the Chinese nagi could be grown in the United States its fruit would be a very pleasant addition indeed; for besides being very agreeable when eaten fresh, it can be stewed, preserved, and used in a multitude of ways. Very good pies are made from it, and as an ingredient in fruit sirup it is very refreshing. (S. P. I. Nos. 22904 to 22906, and 22977.)

POMEGRANATES.

[Chinese name, "Shuh lu."]

Pomegranates (*Punica granatum*) are not indigenous to China but were introduced there from central Asia in the beginning of our present era. To-day they are still considered somewhat as exotics, for the plants are mostly grown as ornamentals. The fruit is considered to be of more or less medicinal value.

In the Shantung Province, however, one finds large specimens of pomegranates growing in the gardens, and quite a number of different varieties can be seen. There are dwarf varieties that grow only a few feet tall and bear but a few small scarlet fruits, while others grow from 15 to 20 feet tall and bear fruits one or more pounds in weight. There are varieties that have a white rind and are red inside and other kinds that are white both outside and inside. A great part of all the pomegranates in China are double flowered and are grown only for ornament. There are pygmy varieties with double dark-red flowers, others with light-red ones; while among the tall kinds one finds every degree of variation, ranging through pure white, striped, and pale-red flowers to very dark red ones.

LITCHIS.

[Chinese name, "Lei tchee."]

The litchi (*Litchi chinensis*) is one of the most popular fruits in China; in fact, in the south it seems to occupy about the same place that the strawberry does with us, as far as appreciation is concerned. No good dinner, even in northern China, is really complete without some of these delicious little fruits. They are eaten fresh, dried, or canned. The litchi has the same reputation that the pineapple has, that is, it is thought by some to be improved by being canned.

There are a great many varieties of litchis as to size, color, flavor, and size of kernel. They are strictly semitropical plants and in China they occur along the coast only as far north as Foochow, on the twenty-sixth parallel of latitude. They require a rich, loamy soil and should not be allowed to suffer from lack of moisture. The trees are propagated by inarching upon seedling stock, but the Chinese admit that the plants are hard to propagate. The dried fruits of the litchi are the so-called Chinese nuts which have become quite common in our American markets.

LONGANS.

[CHINESE NAME, "Long an."]

The longan (*Euphoria longan*) is a near relative of the litchi. The fruit is much smaller and not nearly so well flavored when raw. When canned, however, the longan is improved considerably and is perhaps even of a more delicate flavor than the ordinary litchi. It is also a strictly semitropical tree, but can stand more hardships than the litchi. The fruit, which is naturally brown, is generally artificially changed to a chrome yellow. It is eaten fresh, canned, or dried. In the last condition one can obtain it at the Chinese New Year time even in the most northern cities of the Empire. There are several varieties of longans, differing in size of fruit, productivity, and size of kernel. Their northern limit of growing seems to be, like that of the litchi, the region around Foochow.

FIGS.

The fig (*Ficus carica*) is grown in northern China only as an exotic, mostly in pots and tubs. In the milder parts of China, however, one finds here and there big specimens out in the open. The writer noticed black and white varieties, but the fruits are not great favorites with the Chinese, apparently, and figs are but sparingly grown.

GUAVAS.

Guavas (*Psidium cattleyanum*) are never seen in northern China and are but sparingly met with in central China, and then only as pot plants. Farther south, however, they seem to be grown in regular plantations, as has been reported by various writers.

BANANAS, PINEAPPLES, ETC.

Bananas, pineapples, carambolas, and various other strictly tropical fruits are grown in the extreme south of China; but although the writer observed the fruits in northern markets he was never able to see the plants growing in their various districts.

THE CANARIUM.

The canarium (*Canarium* sp.) closely resembles our green olive. It is hawked all over the Empire and is mostly eaten fresh, or while still unripe is pickled in brine. It is considered an excellent promoter of digestion and an appetizer. Besides the fresh fruit, one can obtain it dry salted, dry sugared, or preserved in sirup. In the last two ways it has a very pleasing flavor, comparing favorably with our preserved citron rind, and could safely be introduced into our western lands as a table delicacy. The shrubs, or small trees, can not stand much cold. Their northern limit on the coast of China seems to be Foochow.

MULBERRIES.

[Chinese name, "Pai sang shu."]

In the neighborhood of Peking a variety of mulberry (*Morus alba*) is grown which produces large white fruit that is very sweet to the taste. It ripens in early June, and is but sparingly met with for sale.

ACTINIDIA.

ACTINIDIA KOLOMIKTA.

There are several species of Actinidia in the Orient. The most common in northern China, Manchuria, northern Korea, and eastern Siberia is *Actinidia kolomikta.* This vine grows here and there in dense masses in the open forests, sometimes covering large areas, crawling over bowlders and smothering all small shrubs. There is much variation in its habits. Some plants are of an open growth, while others are extraordinarily densely branched.

The fruit, too, varies in size and shape, some kinds being as small as and even rounder than a gooseberry, while others are elongated and of the size of small plums. The color is either bright or dull green.

In the foliage one observes at times some curious variations of color. Some plants produce leaves that are either entirely or in part white, silvery colored, or spotted; other plants show a similar variegation, but in the red or rosy-red tints. These variegations are strikingly beautiful when seen in the wild state. The white one produces the effect of a shrub covered with thousands of large white flowers.

The fruit of *Actinidia kolomikta* is edible and is eagerly collected by the inhabitants of the countries where it occurs. The Russian settlers in eastern Siberia dry it and keep it for winter use. They call it "kishmis" and use it baked in bread and pastry. (S. P. I. No. 19479.)

ACTINIDIA ARGUTA.

The species *Actinidia arguta* also occurs wild in Manchuria and northern Korea. It is of much stronger growth, but is seen far less often than the first species. The fruit is larger than that of *Actinidia kolomikta* and is also collected and eaten by the natives. According to information obtained from Unsan, northern Korea, the fruit is called "tara" in that region and is well liked.

ACTINIDIA CHINENSIS.

[Chinese name, "Yang tao."]

The species *Actinidia chinensis* seems to be the largest and most important of all. It grows in the mild-wintered Yangtze Valley, and as far as the writer was able to ascertain is not cultivated at all. The vine is a very rank grower, attaining large dimensions. The fruit is of the shape of a small hen's egg, has a rough skin, and is of a rusty color. It tastes something like a gooseberry, but has other flavors added to it. The missionaries prepare a jam from it that is of very good quality. Plants of this species have been widely distributed of late, and will no doubt show in the near future whether they are productive enough to warrant the very large space they require for successful development. (S. P. I. Nos. 11629 and 21781.)

MISCELLANEOUS SMALL WILD BERRIES.

As has been stated, the Chinese do not seem to like soft fruits very well, especially the wild, berrylike kinds. This is probably the reason why they have never developed any of the excellent wild forms of Rubus which they possess. The ordinary red raspberry (*Rubus idaeus*) grows in large quantities in the mountains of northern China, Manchuria, and eastern Siberia, and although the fruit is not very large it is of a good flavor.

Various other species of raspberries, thimble berries, blackberries, and all sorts of intermediate forms bearing white, yellow, red, or black fruit occur all over China. Dr. Augustine Henry and Mr. E. H. Wilson have collected scores of good species in central and western China, some of which in the near future will give rise to entirely new strains.

The genus Ribes has some promising species in the Orient. Here and there in the high mountains of northern China one finds wild gooseberries and various kinds of wild currants that seem to be able to withstand a drier climate than the varieties of western Europe and may therefore be used in hybridization work.

When traveling through northern Korea in the summer and fall of 1906 the writer found in the highlands of the Changpektchang region hundreds of acres covered with fine blueberries (*Vaccinium myrtillus*), on which his party feasted until their tongues and palates were dark purple and their teeth were on edge. These blueberries are certainly worthy of cultivation in cold, bleak districts where other berries will not grow. Even in the wild state there is a considerable degree of variation among them as to size and sweetness of fruit, and superior varieties could easily be selected and multiplied.

Here and there in shady, moist places, in the same localities where the blueberries were growing, masses of mountain cranberries (*Vaccinium vitis-idaea*) were noticed, but the scarlet, fine-looking berries were somewhat too bitter to be palatable.

In the cooler parts of northern China, Manchuria, northern Korea, and eastern Siberia the snowball (*Viburnum opulus*) often occurs in large masses. In some places the natives collect the scarlet, juicy berries and make preserves of them by boiling the fruit and mixing sugar with the paste.

Schizandra chinensis is a small climbing vine, growing in shady thickets in Manchuria, northern Korea, and eastern Siberia. It bears long, dense clusters of scarlet berries which are eaten by the natives, who claim that the fruit possesses medicinal properties, being a blood purifier. The dried fruit is exported as medicine in large quantities from Manchuria to various Chinese cities. To us, however, this plant would be of value mainly as a graceful ornamental climber. (S. P. I. Nos. 19602 and 20361.)

Besides these regular fruits, many wild things of minor importance are used for food. One of these is too curious to omit. There grows in some parts of China a species of hackberry (*Celtis sinensis*). This tree is sometimes so badly attacked by a gall that it becomes stunted. The Chinese, however, eat these galls while green and before the insect inside is entirely grown. They say that the flavor is exactly like that of a cucumber, and for this reason the tree is called the "Shan huang kwa shu," or wild cucumber tree.

COLD-STORAGE METHODS IN CHINA.

It is a fact of peculiar interest that certain methods or practices which our present generation considers to be particularly its own are found to have been practiced for no one knows how long in some of the oldest countries of the globe. Cold storage is one of them. The Chinese understand the principles of cold storage thoroughly. They are able to keep grapes from one year to another by storing them in deep, dugout cellars that are kept cold with baskets of broken ice placed among the baskets of fruit.

The fruit merchants usually keep perishable fruits in their stores by means of large earthen jars with very thick walls. Broken ice is put in the bottom of the jar and upon this are placed woven wicker baskets in which the fruit is kept. The jar is closed with a wooden cover that often has a strip of felt around it. It is remarkable how well such a simple contrivance serves its purpose.

To obtain the necessary ice there is great activity in the neighborhood of cities and villages in the winter time. Ice even as thin as half an inch is gathered. It is stored in houses with very thick mud walls and kept there nearly the whole year.

NUTS AND NUT CULTURE.

Nuts are appreciated by the Chinese to the same extent that they are all over the world, but nut culture is as little practiced in China as it is elsewhere, for nut-bearing trees and shrubs seem to have the reputation of not needing much cultivation. One therefore finds that a great many of the various nuts obtained in China have been collected from trees and shrubs in a wild or semiwild state.

The nuts which came under the writer's observation are as follows:

WALNUTS.

[Chinese name, "Ho to."]

The walnut (*Juglans regia sinensis*) is a native of northern China and thrives to perfection in the rich, loamy soil of some of the broad, sheltered valleys of that country. In some sections the trees are grown in regular orchards, in other localities one finds them planted here and there as solitary specimens. The latter practice is especially common in the narrow mountain valleys, where terraces have often been made to supply the trees with a sufficient quantity of soil.

The Chinese have not learned the art of grafting or budding the walnut, and all the trees, therefore, are seedlings. Hence, there is an enormous variation in the habits of the trees and in the size and quality of the nuts. In some sections very superior strains of nuts exist, while elsewhere the quality is poor. In the vicinity of Changli, Chihli Province, there are some walnut orchards in which the trees vary to a remarkable degree. Some produce small hard-shelled nuts of poor flavor, while others bear fine large nuts, with a really fine flavor, and having shells so thin that they can be cracked with the fingers like a peanut. Between these extremes one finds many gradations in hardness of shell, size, and flavor. It is very likely that some kinds of these Chinese nuts may prove to be much hardier than our present Persian strain of walnuts and in all probability they will thrive especially well in certain sections of the southern Rocky Mountain region. (S. P. I. Nos. 17745, 17746, 17943 to 17946, 18256, 18257, 18263, 18603, and 18604.)

WILD WALNUTS.

[CHINESE NAME, "Shan ho to."]

At the present time the walnut is but very sparingly met with in the wild state. Northern China has been settled too long to afford us the opportunity of seeing much of her original wild arboreal vegetation. In the Pangshan district, however, to the east of Peking, one may still find a few specimens of the real wild walnut. They are found in the mountains, growing in ravines among large bowlders. The trees are smaller and less vigorous in growth than the cultivated ones. The leaves and nuts are also smaller and the latter less sweet than those from cultivated trees, but otherwise there is little difference. (S. P. I. No. 21877.)

CHESTNUTS.

[CHINESE NAME, "Li tze."]

The ordinary Chinese chestnut (*Castanea* sp.) grows wild on the slopes of rocky mountains in northern China and southern Manchuria. It is mostly found in groves, growing among rocks and bowlders, and even in its wild state it varies considerably in the size and flavor of its nuts and the spininess of the burrs. The Chinese name for the wild form is "San li tze." (S. P. I. No. 21875.)

The nuts have been planted to some extent on the mountain slopes by the Chinese, where the trees receive more or less cultivation. All the trees being seedlings, there is very great variation among them in regard to their productivity and the size and relative sweetness of the nuts. The nuts are sold extensively in autumn and early winter in all Chinese towns, after being roasted in sand with which molasses has been mixed. This roasting in sugared sand bleaches the nuts somewhat, makes them shiny, and cracks them open but very little.

The chestnut of northern China is quite distinct from that of Japan; it can stand great heat and drought, and may be especially useful in the Rocky Mountain region of the United States. (S. P. I. Nos. 17876, 17877, and 17896.)

There is a very slender-leaved chestnut found growing in some of the ravines of southeastern Manchuria and northeastern Korea. The nuts are small, but when the tree is in flower it is very ornamental, its snowy-white masses of catkins contrasting vividly with the slender, glossy, green leaves.

In the more elevated mountain regions of China a dwarf chestnut occurs, generally as a shrub several feet high. The nuts are small but very sweet. The whole plant is very similar to the North American chinquapin. It can be used as a fruiting shrub. Its nuts are very sparingly seen in the markets of central China during the early winter.

HAZELNUTS.

Three wild species of hazelnuts occur in the mountains of northern China, Manchuria, and eastern Siberia. They are *Corylus heterophylla*, *C. mandshurica*, and a third species. They are never cultivated, but the nuts are collected and sold on the markets throughout the Far East. They are inferior to the filbert, but seem to be able to stand, in general, more drought and hardship. For this reason they might be tried in the drier sections of the United States where ordinary filberts do not succeed.

EDIBLE PINE SEEDS.

Pine kernels are sold in fruit stalls and markets all over the Far East and are eaten as delicacies. Most of these come from the *Pinus koraiensis*, which grows as a stately tree in the virgin forests of Manchuria, Korea, and eastern Siberia. They are called "Sung tze." (S. P. I. Nos. 20089, 20090, 20315, 20316, and 23220.)

Besides this pine, there are a few others that supply these kernels. In the Province of Shansi a small round pine kernel is sold. It may be the seed of *Pinus bungeana*. It is called "Kuo tze" and "Sung tze." (S. P. I. Nos. 21997 and 22691.) In southern and central China some very elongated kernels are occasionally to be had. These nuts are often used by the higher classes for cake and pastry.

APRICOT KERNELS.

Foreigners in China are often served in various homes and hotels with so-called almond cake. One of the main ingredients of this cake is sweet kernels, so closely resembling almonds that even intelligent foreigners believe that they are eating genuine almonds. This supposition has given rise to the statement that almonds grow in China. These so-called Chinese almonds are the kernels of a particular kind of apricot (*Prunus armeniaca*), grown exclusively for its seeds.

There are several varieties of apricots that produce these seeds. The best one has small red fruit with large, medium-soft stones and sweet kernels. The tree of this particular variety is of very erect growth, quite distinct from all other varieties of apricots. It is propagated by grafting upon seedling stock.

Another variety bears somewhat larger fruit, also of a red color, but the tree is of an open habit. Then there is a yellow-fleshed variety that resembles the preceding one very much in habit of growth. The stones of the last two varieties are not so easily cracked, however, as those of the first-mentioned kind.

Another variety that came under the writer's notice has a bitter kernel, used only in small quantities to give flavor to confectionery and to make the so-called Chinese almond soup. In preparing the latter, rice is cooked until it is quite soft, then pounded and mixed with water until it closely resembles milk, then a few bitter "almonds" are ground up and mixed with this rice milk, some sugar is added, and it is served hot. It makes a delicious, stimulating soup of which the Chinese are very fond of partaking in the evening just before retiring.

The sweet apricot kernels are often served with true nuts and raisins. Sometimes they are salted. They look and taste exactly like small salted almonds, so that it really is no wonder that foreigners have come to consider them as a particular kind of Chinese almond. (S. P. I. Nos. 17153, 17845, 18260, and 18261.)

GINGKO NUTS.

[CHINESE NAME, "Pai kua," meaning white nut.]

The gingko (*Gingko biloba*) is grown in China as a much appreciated tree in the courtyards of Buddhist temples and near shrines. The white nuts are eagerly collected, cleaned of the ill-smelling pulp that surrounds them, and sold as a delicacy, especially in central and southern China. They are always slightly roasted before being eaten, but their flavor does not appeal to the palate of the Caucasian race.

CASTANOPSIS SEEDS.

The castanopsis (*Castanopsis tibetana*) is a stately evergreen tree, bearing edible, chestnut-like seeds. The tree grows 100 feet tall and has a trunk several feet in diameter. It bears glossy dentate leaves, dark green above and rusty brown beneath, which sometimes reach a length of 1½ feet and a breadth of 9 inches. The tree is found sparingly in protected mountain valleys in the Chekiang Province. It was discovered in the vicinity of Hangchow by Bishop G. E. Moule, of the Church of England Missionary Society, through whose efforts we were able to obtain a small quantity of the seeds, which are not easy to obtain. The nuts being edible, the priests of the various temples are very fond of them, and the many rodents abounding there also get their share as soon as they ripen, so that one has to be on the spot at the right season to secure a supply.

This castanopsis will probably grow in those sections of the United States where oranges and loquats thrive, where the soil is rich and deep and where some shelter can be afforded to the plants, at least while they are young. (S. P. I. No. 22915.)

WATER CHESTNUTS.

[Chinese name, "Feng ling."]

Peculiar water chestnuts (*Trapa bicornis*), resembling a buffalo head, are extensively grown in all the canals and placid streams of the Chehkiang Province. The Chinese plant them in early spring and protect the plants by means of fences of bamboo stalks staked in the water. The nuts are eaten boiled and taste somewhat like a Jerusalem artichoke.

The labor involved in collecting the seeds and protecting the plants makes this crop one that is not likely to succeed in any country except where labor is exceedingly cheap and plentiful.

VARIOUS EDIBLE SEEDS.

PEANUTS.

Peanuts (*Arachis hypogaea*) are cultivated extensively all over China. They are grown for oil extraction and for food.

The nuts are planted in the spring in sandy soil and are harvested in the fall; but they are considered so valuable that the soil in which they grow is sifted so as to get even the smallest nuts. A field of 10 or 20 acres that has been thus sifted, with the heaps of soil lying on it in regular lines, looks as if manure had been carted on in compact heaps.

There are but few varieties of peanuts in China. The ordinary large kind is the same as seen elsewhere and is called by the Chinese the "foreign peanut." Its introduction seems to be quite recent. It is used almost exclusively as a delicacy, roasted as in western countries.

There is a small variety, however, with a peculiar shrunken skin, that is used in an entirely different way. These nuts are steamed with salt water and kept in weak brine until used. They are everywhere eaten cold as appetizers, and although small are really very palatable and nutritious. Sometimes the kernels are taken out, salted, and served at dinners, but on account of their small size they are being replaced by the larger variety. (S. P. I. No. 22022.)

WATERMELON SEEDS.

Watermelon seeds are in great favor with the Chinese as delicacies, and no one can go to the theater or to a tea house without being offered some. They are always served roasted.

There are several varieties—some red, others black, yellowish, and even white. The red varieties seem to be considered the best. The Chinese grow a few strains of these watermelons solely for their seeds, for which there is always a great demand. It might perhaps be profitable for American farmers to obtain a very large-seeded variety of watermelon and grow it exclusively for its seeds, to be exported to China.

SQUASH AND PUMPKIN SEEDS.

Pumpkin seeds of the species *Cucurbita maxima*, *C. pepo*, and *C. moschata* are roasted and eaten as delicacies all through China, and also by the Russian settlers in eastern Siberia.

BOTTLE-GOURD SEEDS.

Seeds of the bottle gourd (*Lagenaria vulgaris*) are boiled in salted water and eaten when cold as appetizing delicacies by the rural classes in China.

SUNFLOWER SEEDS.

Sunflower (*Helianthus annuus*) seeds are consumed extensively, either roasted or raw, as delicacies, all through China and Siberia. The black and white striped seeds seem to be the most in favor and are grown in great quantities for domestic use.

FIRMIANA SIMPLEX.

The seeds of the plant frequently known as *Sterculia platanifolia*, the correct name of which is *Firmiana simplex*, which is grown all through China as a favorite shade tree, are sold sparingly as delicacies in central China. They are far from being of good flavor, however, and as a food will never become of any importance to western races.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 205.

B. T. GALLOWAY, *Chief of Bureau.*

SEEDS AND PLANTS IMPORTED

DURING THE PERIOD FROM OCTOBER 1 TO DECEMBER 31, 1909:

INVENTORY No. 21; Nos. 26048 to 26470.

ISSUED MARCH 17, 1911.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., October 31, 1910.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 205 of the series of this Bureau the accompanying manuscript, entitled "Seeds and Plants Imported During the Period from October 1 to December 31, 1909: Inventory No. 21; Nos. 26048 to 26470."

This manuscript has been submitted by the Agricultural Explorer in Charge of Foreign Seed and Plant Introduction with a view to publication.

Respectfully,

G. H. Powell,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—625.

SEEDS AND PLANTS IMPORTED DURING THE PERIOD FROM OCTOBER 1 TO DECEMBER 31, 1909: INVENTORY NO. 21; NOS. 26048 TO 26470.

INTRODUCTORY STATEMENT.

Although our agricultural explorer Mr. Frank N. Meyer has been in the field during the period covered by this inventory, the material received from him which is herein recorded is but a small part of the work performed by him. He has been investigating the prevalence of the crown-gall disease of the apple in France for the purpose of ascertaining whether the French have resistant stocks; making studies in the English, French, German, and Russian arboreta for the purpose of familiarizing himself with the important plants and plant cultures of Chinese Turkestan, which region it is expected he will explore this summer; and he has been unexpectedly delayed for six weeks in St. Petersburg. This office is negotiating by correspondence for the valuable material he has reported in the different arboreta.

To the fruit growers the question of better stock plants is of great importance and is being emphasized more strongly now than ever before. To such as are working on the problem, the introduction from Palestine, through Mr. Aaron Aaronsohn, of a large red-fruited variety of haw, *Crataegus azarolus* (Nos. 26116 and 26354), will be interesting. It has been used successfully both in Tunis and Palestine and is considered by Mr. Aaronsohn to be an ideal stock for dwarf early pears in our arid irrigated regions of the Southwest, where the question of growing early pears is attracting attention. A species of Photinia (No. 26133) from western China is sent in by Mr. Meyer, who suggests its use as a possible stock for the loquat.

The possibility of using the Chinese brambles for the production of new types of raspberries has been pointed out as promising. For those interested in this field, nine species of Rubus from the Yangtze Valley (Nos. 26270 to 26278), collected by Mr. E. H. Wilson, of the Arnold Arboretum, are likely to prove of very considerable interest.

The problem of growing in this country the large-fruited English gooseberry has proved difficult to solve because of the gooseberry mildew to which all English gooseberry varieties seem subject. Those interested in this fruit will be glad to test Dr. W. Van Fleet's three new hybrids between *Ribes missouriense*, *R. cynosbati*, and *R. rotundifolium* crossed by *R. reclinatum*. These represent twelve years of careful work in selection from hundreds of seedlings from various crosses, and preliminary tests have shown them remarkably resistant to the gooseberry mildew. (Nos. 26138 to 26140.)

Feijoa sellowiana (Nos. 26120 and 26121) is a new fruit from Uruguay which is attracting some attention in California and Florida, since it is said to withstand more cold than the guava and to have a unique flavor of its own which is especially relished by many. An acid-fruited species of *Psidium laurifolium* (No. 26413), from Trinidad, will interest those who believe in the future of the guava and its jelly-making qualities, since it is said to jelly much quicker than the common West Indian varieties and, quite distinct from them, to have an agreeable acidity.

To the Florida and California fruit growers who are watching the possibilities of the anonas, the introduction of eight large-fruited, smooth-skinned varieties from Chile will be of interest. (Nos. 26148 to 26155.)

The loganberry is already well known in the United States and those who realize its value will doubtless wish to test the lowberry (No. 26197) and Low's Phenomenal raspberry-loganberry hybrid (No. 26198), which are said to be new rivals of the loganberry.

Those who are experimenting with forage plants will be interested in a new importation of shaftal, *Trifolium suaveolens*, from Tashkend (No. 26135), a clover which is being given a thorough trial in the irrigated regions of the Southwest. Although normally an annual, this species behaves as a perennial if regularly cut for hay. The Wallaby grass, *Danthonia semiannularis*, from New Zealand (No. 26119), is recommended especially for heavy clay soils or gumbo lands subject to drought; and ray-grass, *Lolium strictum* (No. 26200), coming from the dry regions along the Mediterranean, is recommended by the veteran experimenter, Doctor Trabut, of Mustapha, Algiers, as being an excellent forage grass, an annual worthy of cultivation in the Southwest; while the New Zealand rice-grass, *Microlaena stipoides* (No. 26118), may find a use in America for pasture or lawn purposes.

Potato breeders have already shown an interest in the introduction of a few tubers of a species of Solanum thought to be a wild hybrid of *Solanum tuberosum* (No. 26122), which has been used by Mr. Paton, of Scotland, to originate what he believes are varieties practically immune to the potato blight, *Phytophthora infestans*. Interesting varieties have also been introduced from Bogota, Colombia (Nos. 26126 to 26129).

The Arracacia of South America forms a staple food of the Venezuelans, who know it under the name of apio. It is cultivated in high altitudes and requires a long season in which to mature. It deserves a thorough trial in the South to determine where it will succeed. (No. 26204.)

The destructive fungous disease of the chestnut, which threatens to destroy the native chestnut trees of the Atlantic coast region, makes the production of a chestnut-chinquapin hybrid of unusual interest, since its resistance to this bark disease may furnish a way out of a situation which seriously threatens the chestnut industry. Doctor Van Fleet's hybrids (Nos. 26230 to 26235) have so far shown a high degree of immunity to the disease.

The interest in the Japanese flowering cherry trees, which have been found to succeed well in the United States, makes it worth while to call attention to seven Chinese flowering cherry trees from the Yangtze Valley, collected by Mr. E. H. Wilson, of the Arnold Arboretum. (Nos. 26246 to 26252.)

For many years attempts have been made to introduce the cliff-grown tea and the teas from the Dragon Pool, of the Kienningfu and Wuishan districts of China, but without success. Through the kind assistance of Mr. Rockhill, ambassador to Russia, formerly American ambassador to China, and the hearty cooperation of the American consul and vice-consul at Foochow, fourteen varieties of these specially noted teas have been introduced and are being propagated.

As heretofore, the work of identification and nomenclature, as well as that on the geographical distribution, has been done by Mr. H. C. Skeels under the supervision of Mr. W. F. Wight, of the Office of Taxonomic and Range Investigations, and the manuscript has been prepared by Miss Mary A. Austin.

DAVID FAIRCHILD,
Agricultural Explorer in Charge.

OFFICE OF FOREIGN SEED AND PLANT INTRODUCTION,
Washington, D. C., March 7, 1910.

INVENTORY.

26048 and 26049. PRUNUS spp.

From the Himalayas. Presented by Mr. E. Shearer, Assistant Inspector-General of Agriculture in India, Nagpur, Central Provinces, India. Received October 2, 1909.

Seeds of the following:

26048. PRUNUS ARMENIACA L. **Apricot.**

"*Shari.* A nursery of shari plants is prepared in January each year. The soil is first dug, properly cleaned, and manured; ditches are then made about 4 inches deep and the seeds are put in and covered with earth. These seeds germinate in the following March.

"These plants are then transplanted where desired in January next, i. e., after one year. They are planted in pits dug deep enough and are watered every second or third day until they take root in the ground. Shari plants when grafted with aru (peach) give a better variety of shari fruit." (*Shearer.*)

26049. PRUNUS sp. **Plum.**

"*Aloocha.* The season and process of sowing this seed are the same as that of shari (apricot) (S. P. I. No. 26048).

"Jamun (wild cherry) and aru (peach) when grafted on aloocha plants produce fine varieties of jamun and aru, respectively." (*Shearer.*)

26050. ALEURITES TRISPERMA Blanco. **Banucalag.**

From Philippine Islands. Presented by Mr. Elmer D. Merrill, Bureau of Science, Manila. Received October 2, 1909.

"As there are probably no live specimens of this species in America to-day, these seeds were procured to grow plants for trial in the tropical possessions of the United States. A portion of them will also be used for the expression of a sample of oil to be tested in the Bureau of Chemistry of the United States Department of Agriculture in Washington in comparison with oils derived from other species of Aleurites.

"This species, which yields a valuable drying oil, is found in the Philippines; so far as known, it is restricted to these islands and is comparatively rare but quite generally distributed. This plant is botanically known as *Aleurites trisperma* Blanco, but carries also the synonym *Aleurites saponaria* Blanco. It is known locally as 'banucalag,' 'lumbang banucalag,' 'lumbang banucalad,' 'baguilumban,' 'calumban,' or 'lumbang gubat,' besides having a variety of other names in the different provinces. It is much mixed and confused with the true lumbang (*Aleurites moluccana*), especially when information in regard to it is sought.

"*Aleurites trisperma* belongs to the same section of Aleurites as the Chinese and Japanese species; this may readily be seen by comparing the seeds and foliage of these three plants. The seeds resemble those of *Aleurites fordii*, while the leaves resemble those of *Aleurites cordata*. The seeds are somewhat larger, however, than those of the China wood-oil tree, besides being thicker shelled and of a distinct brick-red color." (*W. Fischer.*)

26051 to 26054. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

From Nanking, China. Presented by Dr. F. B. Whitmore. Received September 13, 1909. Numbered October 4, 1909.

Seeds of each of the following:

26051. Yellow.

26052. Yellowish green.

26053. Green.

26054. Black.

26055 to 26061. SACCHARUM OFFICINARUM L. **Sugar cane.**

Presented by Mr. Edward W. Knox, general manager of the Colonial Sugar Refining Company (Limited), Sydney, New South Wales, Australia. Received October 4, 1909.

Seeds of each of the following; notes by Mr. Knox:

26055. *Striped Singapore.* "Standard variety, medium thickness, medium quality. Very similar to Rose Bamboo, but striped amber and red."

26056. *Rose Bamboo.* "Standard variety, medium tonnage and sweetness, medium thickness, straw-rose color."

"These are at present most grown in the drier districts of Fiji, being of very fair weight and sweetness. According to Mr. J. Clark (one of our officers who recently paid a visit to Demerara and Barbados) Striped Singapore is the striped variant of the cane called White Transparent in the West Indies; Rose Bamboo is an allied cane which is very nearly identical with White Transparent, the latter being called Yellow Singapore in Fiji. The obvious difference between Rose Bamboo and Yellow Singapore is that the latter is somewhat thicker in the stalk and arrows very freely, while the former rarely flowers."

26057. *Badila.* "Best variety in Fiji and Queensland. Very heavy and very sweet, thick, purple."

26058. *Mohona.* "Early maturing, successful variety in New South Wales, but dies off early in the season in tropical Queensland and Fiji; rather thin, purple; white bloom."

"These have been obtained from New Guinea. Badila is a dark-purple cane of stout build, giving heavy and sweet crops under favorable conditions, but being a slow grower at the start. Mohona is of a lighter purple color, of medium size and yield, attaining high sweetness when comparatively young, readily going back in quality in the Tropics, but much more enduring in semitropical districts. It supplies very fertile seeds."

26059. *HQ. 10.* "Fairly sweet variety, fair tonnage, seedling raised from Mohona by Mr. J. Clark at Hambledon, Queensland. Thin, olive-green."

26060. *HQ. 50.* "Seedling raised from Mohona; rather thin, purple; white bloom; good cropper; good quality; raised at Hambledon, Queensland."

"These are both sweet and have given fair crops so far when tried on small areas only."

26061. *Couvé 87.* "This is a thick, purple Mauritius seedling, giving a heavy crop, which is somewhat discounted by shortcomings as regards quality. Seed from this variety is more fertile than that from any other known by us."

26062 to 26065. MUSA TEXTILIS Née. **Manila hemp.**

From Davao, Mindanao, Philippine Islands. Presented by Mr. M. M. Saleeby, in charge of fiber plants, Bureau of Agriculture, Manila, through Mr. Lyster H. Dewey. Received October 4, 1909.

26062 to 26065—Continued.

Seeds of each of the following:

26062. *Tanguyon* (also spelled *Tangouan* and *Tongongon*).

26063. *Libuton.*

26064. *Puteean.*

26065. *Arupan.*

"Mr. Saleeby, who is making a careful study of abacá (Manila hemp), writes that although abacá seedlings are often found in the fields in well-shaded moist places, he has never found good plants growing directly from the seeds. He suggests trying to grow plants from root cuttings or suckers from the seedlings that we may secure. He also states that he finds seedlings only in soil well drained yet constantly moist and constantly shaded. I would suggest that these seeds be grown with a view to sending the young plants to Porto Rico." (*Dewey.*)

26067. BETA VULGARIS L. **Beet.**

From Sicily. Presented by Dr. Carl Sprenger, Hortus Botanicus Vomerensis, Vomero, Naples, Italy. Received October 5, 1909.

Seed collected in a wild state.

26068. APIUM GRAVEOLENS L. **Celery.**

From France. Presented by Mrs. E. M. Sheridan, 2300 G street NW., Washington, D. C., who procured the seed from Vilmorin-Andrieux & Co., Paris, France. Received October 5, 1909.

Improved Paris celeri-rave (Falaise). "The taste of this is similar to the meat of the large artichoke and only requires boiling and a dressing of drawn butter gravy after it is cut in slices or small chunks." (*Sheridan.*)

"Sow in February or March in a bed under glass; set out in well-manured ground at a distance of 30 to 40 centimeters (12 to 16 inches). Harvest in August and September.

"Plant in nursery beds in April or May; set out in May or June. Gather in October or November and keep during the winter.

"A variety obtained by Mr. Falaise and distinguished from the common celeri-rave by a much greater development of the root. Foliage tolerably high with slender petioles, dark green, strongly tinted with red; the leaves themselves are large, tolerably serrate, of a dark and shining green, especially on the upper part of the stalk. It is the race most liked by the Parisian market gardeners; it is an improvement on Large Smooth Paris celeri-rave, which it has replaced and which was itself a good selection from Common celeri-rave." (*Vilmorin-Andrieux & Co.*)

26069. ARALIA CORDATA Thunb. **Udo.**

From New York, N. Y. Purchased from J. M. Thorburn & Co. Received October 7, 1909.

Kan. See Bureau of Plant Industry Bulletin 42 for description; also S. P. I. No. 9166.

26070 to 26077. MEDICAGO spp.

From Chico, Cal. Grown at the Plant Introduction Garden by Mr. Roland McKee. Received September 22, 1909.

Seeds of the following; descriptive notes by Mr. McKee:

26070. MEDICAGO HISPIDA CONFINIS (Koch) Burnat.

"This is a selection from S. P. I. No. 16771 made at Chico, Cal., in 1906. It is a prickleless form of bur clover and well adapted for pasturage, especially for sheep. It should be tested throughout the southern and southwestern United States. It has been grown for the increase of seed."

26070 to 26077—Continued.

Distribution.—The British Islands, France, Spain and Portugal, Italy, and the Balkan Peninsula.

26071. MEDICAGO HISPIDA NIGRA (L.) Burnat.

"Seed in the bur was received at the Plant Introduction Garden, Chico, Cal., in December, 1905, from the University of California. It perhaps will succeed wherever *M. hispida denticulata* or *M. arabica* does well. In California it is perhaps a little more aggressive than *M. hispida.* Of value for pasturage and soil improvement."

Distribution.—The European countries bordering on the Mediterranean Sea, including Spain, southern France, and Italy; also in the Balkan Peninsula, Asia Minor, Syria, Palestine, and northern Africa.

26072. MEDICAGO HISPIDA NIGRA (L.) Burnat.

Same as No. 26071.

26073. MEDICAGO HISPIDA Gaertn.

"Seed in the bur was received at the Plant Introduction Garden, Chico, Cal., in December, 1905, from the University of California. Of value for pasturage and soil improvement wherever common bur clover is adapted."

Distribution.—The Mediterranean region.

26074. MEDICAGO HISPIDA Gaertn.

Same as No. 26073.

26075. MEDICAGO HISPIDA TEREBELLUM (Willd.) Urban.

"Seed in the bur received at the Plant Introduction Garden, Chico, Cal., in December, 1905, from the University of California. This is practically a prickleless form of bur clover and needs to be tested extensively in the West and South for pasturage and soil improvement."

Distribution.—The countries along the Mediterranean, from Spain to Palestine and Egypt.

26076. MEDICAGO MURICATA (L.) All.

"This is a selection made from seed which was received at the Plant Introduction Garden, Chico, Cal., in December, 1905, from the University of California. It is a form of bur clover having a large but very hard bur. Should be tested in sections adapted to bur clovers."

Distribution.—The province of Riviera, southern France, and in Dalmatia, Croatia, and Herzegovina, southern Austria.

26077. MEDICAGO SCUTELLATA (L.) Miller.

"Seed in the bur was received at the Plant Introduction Garden, Chico, Cal., in December, 1905, from the University of California. This is a form of bur clover having a very large papery pod, making it especially desirable for pasturage. It should be tested in particular in the warmer sections of the South."

Distribution.—The Mediterranean region.

26078. CAPRIOLA INCOMPLETA (Nees) Skeels.

Cynodon incompletus Nees, Linnæa 7: 301. 1832.

The genus Capriola was established by Adanson in 1763, while Cynodon was not published until 1805, forty-two years later. Dactilon was proposed for the same genus by Villars in 1787 and Fibichia by Koeler in 1802.

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, government agrostologist and botanist, Transvaal Department of Agriculture. Received October 14, 1909.

"This is closely related to common Bermuda grass." (*C. V. Piper.*) (Roots.)

26078—Continued.

Distribution.—This species occurs in South Africa and was originally described from "Gaaup," in the district of Beaufort, Cape Colony. It has since been found in various localities from the vicinity of Lydenburg, Transvaal Colony, southward, and westward to the banks of Orange River in Little Namaqualand. In the central region of Cape Colony it is found at elevations of 3,000 feet.

26109. ZIZYPHUS SATIVA Gaertn. **Chinese date.**

From Chekiang Province, China. Presented by Mr. J. H. Judson, Hangchow, China. Received April 21, 1908. Numbered October 6, 1909.

"I can not say whether these plants are of a named variety or not. The Chinese have three kinds on the market, which they call red, black, and honey dates." (*Judson.*)

26110 and 26111.

From Beirut, Syria. Presented by Mr. A. E. Day, professor of natural science, The Syrian Protestant College. Received October 8, 1909.

Seeds of each of the following:

26110. CUCURBITA PEPO L.

"*Kusa.*" See No. 22810 for description.

26111. CUCUMIS SATIVUS L. **Cucumber.**

"We eat freely of this cucumber, and it is a common sight to see a Syrian child one or two years old chewing away at one; it does not seem to hurt them." (*Day.*)

26112. DIOSPYROS DISCOLOR Willd. **Mabola fruit.**

From Philippine Islands. Presented by Mr. William S. Lyon, Gardens of Nagtajan, Manila. Received October 11, 1909.

"A small tree, native of the Philippine Islands, introduced into India and cultivated in gardens, especially in Vizagapatam. The fruit is like a large quince and in some places is called mangosteen; its proper name should be the *Mabola* fruit. It is agreeable and has a pink-colored fleshy rind." (*Extract from Watt, Dictionary of Economic Products of India, vol. 3, p. 138.*)

See No. 19216 for previous introduction and description.

26115. MUCUNA GIGANTEA (Willd.) DC.

From Buntal, at the mouth of Sarawak River, Sarawak, Borneo. Presented by Mr. J. C. Moulton, curator, Sarawak museum. Received October 12, 1909.

Black. See No. 25514 for distribution.

26116. CRATAEGUS AZAROLUS L.

From Zichron-Jacob, near Haifa, Palestine. Presented by Miss Rifka Aaronsohn, through Mr. A. Aaronsohn. Received October 4, 1909.

"Arabian name za'arur. This species is very abundant throughout the Orient, where a great many varieties and forms of it are found. It grows wild on the slopes of dry, arid hills, preferably amongst calcareous rocks. It is a shrub with spiny branches from 1.5 to 4 or 5 meters in height, with a diameter of 10 to 30 centimeters. It is rather a slow grower.

"In the spring it bears dense corymbs of white flowers which are pleasantly fragrant. The size of the fruits varies in different varieties. Some have fruits as large

26116—Continued.

as 1 inch in diameter. The acid flesh has a delicate flavor, but there is not enough of it to give the fruits a commercial value. Fruits are occasionally found, however, that are practically without seeds and it might be possible to fix this character by selection. As it is the fruit is often sold in the oriental markets.

"I particularly recommend this Crataegus as a stock for pears. It is good for dry localities at any altitude. It is found as low as 200 meters below the level of the Mediterranean in the valley of the Jordan and as high as 1,800 meters above sea level in the desert near Petra. It ought, therefore, to thrive in southern California as well as on the plateaus of Colorado.

"My personal experience has shown that a top graft 6 inches or a foot above the ground is the best for this stock. It is best suited for the early varieties of pears.

"I recommend this as a stock, therefore, in high, arid situations where water is scarce or costly. It is an ideal stock for dwarf early pears. At Indio, Cal., for instance, it ought to yield prime fruit with very little irrigation.

"Palestine (where my father has had trees grafted in this way for 18 years) is not the only region in which *Crataegus azarolus* has been used as a stock for the pear. Mr. Dumont has used it for the same purpose near Tunis.

"I speak of pears because I have had personal experience with this fruit. But I can see no reason why it would not do as well as a stock for dwarf early apples." (*A. Aaronsohn.*)

Distribution.—A native of southern Europe, western Asia, and northern Africa, being found in Spain, Italy, Crete, Caucasia, Asia Minor, Syria, Palestine, Arabia; Persia, and Algeria.

26117. Medicago sativa L. **Alfalfa.**

From Indian Head, Saskatchewan, Canada. Presented by Mr. Angus Mackay, superintendent, Dominion Experimental Farm for Saskatchewan, through Mr. Charles J. Brand. Received October 18, 1909.

Grimm.—"Grown at Indian Head from S. P. I. No. 12991; seeded in comparison with eight other strains in the spring of 1905. No. 12991 was produced in Minnesota in 1904 and was secured from Mr. A. B. Lyman, Excelsior, Minn. In the Indian Head experiments it has proven from the first (1905 to 1909) to be the best of the nine strains under test." (*Brand.*)

26118 and 26119.

From Wellington, New Zealand. Presented by Mr. T. W. Kirk, Biologist, Department of Agriculture. Received October 18, 1909.

Seeds of the following:

26118. Microlaena stipoides (Labill.) R. Br. **New Zealand rice-grass.**

A native grass, much relished by all kinds of stock; the herbage is of a rich green color, and is produced in great abundance.

Distribution.—A native of New Zealand and Australia, where it is widely distributed and used for a lawn and pasture grass.

26119. Danthonia semiannularis (Labill.) R. Br. **Wallaby grass.**

A grass which does well on any of the poorer classes of gumbo land, also on heavy clay soils. It stands drought with impunity, and throws up a good quantity of feed, which is eaten by all classes of stock.

See No. 21024 for previous introduction.

Distribution.—New Zealand, Tasmania, and the temperate parts of Australia.

26120 and 26121. FEIJOA SELLOWIANA Berg.

From Los Angeles, Cal. Presented by Mr. H. Hehre. Received October 11, 1909.

Seeds of the following:

26120. "These fruits were raised from a plant imported by me from Europe a number of years ago and which has been bearing regular crops for five or six years." (*Hehre.*)

26121. "These fruits are from a plant originated by me from seed imported from Europe; it has not been named. Ripens later than the preceding variety." (*Hehre.*)

"*Feijoa sellowiana* is worthy to be mentioned under promising new fruits and deserves the widest distribution. The plant stands more cold than the guava, is beautiful in bloom, and is evergreen. The fruit is green and when ripe has a tinge of yellow. As it blooms for a period of about two months, so does the fruit ripen successively for two months; therefore there are all sizes of fruit on the plant at the same time, which grow at the leaf axil on new wood." (*Hehre.*)

Distribution.—Found in the province of Rio Grande do Sul, in the southeastern part of Brazil, and in the vicinity of Montevideo, Uruguay; cultivated in southern Europe.

26122. SOLANUM sp. **Potato.**

From Castle Kennedy, Scotland. Presented by Rev. J. Aikman Paton, Soulseat. Received October 19, 1909.

"Tubers of *Solanum etuberosum* (so called; I think it is a wild hybrid of *S. tuberosum*, simply), which I used as the parent of my 'Immune' strain. A certain proportion of the 'selfed' seedlings of it and its hybrids are immune to *Phytophthora infestans* even here." (*Paton.*)

26123. CITRUS BERGAMIA Risso. **Bergamot orange.**

From Nice, France. Presented by Dr. A. Robertson Proschowsky. Received October 20, 1909.

Variety *mellarosa plena.* (Cuttings.)

26124. TRIFOLIUM SUBROTUNDUM Steud. & Hochst.

From 70 miles east of Lake Victoria Nyanza, British East Africa, at about 7,500 feet altitude. Presented by Mr. E. Blackbun, Salem, Ohio. Received October 19, 1909.

Distribution.—A native of Abyssinia, where it is cultivated as forage, under the name of Mayad; also native of Upper and Lower Guinea.

26125. MANGIFERA INDICA L. **Mango.**

From Port of Spain, Trinidad, B. W. I. Presented by Mr. F. Evans, Department of Agriculture. Received October 19, 1909.

Julie. "This plant is grafted upon the common mango, *Mangifera indica.*" (*Evans.*)

See No. 21515 for description.

26126 to 26129. SOLANUM spp. **Potato.**

From Bogota, Colombia. Presented by Mr. Eugene Betts, American vice and deputy consul-general. Received October 18, 1909.

Tubers of the following; quoted notes received with the shipment:

26126. "*Pápas Tocanas.* Produced on high, broken ground, mountain sides, high and very cold."

26126 to 26129—Continued.

26127. "*Pápas Arrayanas, criallas coloradas.* Produced on the mountain tops and on high table lands."

26128. "*Pápas Paramunas.* Produced on the mountain slopes above the Savannah of Bogota."

26129. "*Pápas Amapalá.* Produced on the Savannah of Bogota."

26130. MEDICAGO SATIVA L. **Alfalfa.**

From Talas, Caesarea, Turkey. Presented by Dr. Wm. S. Dodd, through Mr. Charles J. Brand. Received October 19, 1909.

"In his letter transmitting this seed Doctor Dodd states: 'I am not sure whether the lucern for which you ask is the plant that we cultivate here for horse feed or not, but I send some of that. Yonja is the Turkish name.' Only a small package of this seed was received, and it should be reserved for experiments in the Southwest." (*Brand.*)

26132 and 26133.

From Mr. Frank N. Meyer, Agricultural Explorer. Received October 13, 1909.

Seeds of the following:

26132. PRUNUS sp.

From China. Obtained at the M. L. de Vilmorin Arboretum, Les Barres, Nogent sur Vernisson, France.

26133. PHOTINIA VILLOSA (Thunb.) DC.

From Western China. Obtained at the M. L. de Vilmorin Arboretum, Les Barres, Nogent sur Vernisson, France. "This plant has a rather dwarfy habit, is apparently evergreen in a climate not too cold, and may serve as a stock for loquats, besides being also ornamental. The plant will probably not be hardy in Washington, D. C." (*Meyer.*)

Distribution.—A native of the southeastern provinces of the Chinese Empire and of Formosa, and widely distributed in Japan.

26134. ALLIUM CEPA L. **Onion.**

From Denia, Spain. Procured from Señor Don Luis Tono, American consular agent, through Mr. Robert Frazer, jr., American consul, Valencia, Spain. Received October 20, 1909.

"Seed of the onion that is commercially grown on an extensive scale in Denia. These onions come upon the American market in a peculiar type of package and are the large yellow or straw-colored onions which are sold under the name of Spanish onions. The closest American representative of this type is the Prizetaker, which I understand is an American sport from this variety. It is probably the largest of the onions which are grown extensively for market, has the thinnest skin, is the mildest in flavor, and altogether is the best onion produced in the world. From imported seed we have succeeded in producing some very fine specimens in parts of Texas, and we hope that from this small beginning a very considerable industry will be built up. The probabilities are that we shall always need to import the seed direct from Spain in order to maintain the high quality in the American-grown product." (*L. C. Corbett.*)

26135. TRIFOLIUM SUAVEOLENS Willd. **Shaftal, or schabdar.**

From Tashkend, Turkestan. Purchased from Dr. Richard Schröder, director Chief Agricultural Experiment Station, at the suggestion of Prof. N. E. Hansen, Agricultural Experiment Station, Brookings, S. Dak. Received October 23, 1909.

26135—Continued.

The following notes were taken from a letter written by Doctor Schröder to Professor Hansen; clause in brackets is by Professor Hansen:

"In Persia the schabdar seed is usually sown in the fall, not too late. It endures the winter quite well. By sowing in the fall it develops in the spring so quickly that the first cutting is ready before the first cutting of alfalfa. According to information obtained in Persia the schabdar endures several years. This lot is of a new variety which endures from five to seven years. The fact that this plant is perennial comes in conflict with botanical statements [that it is an annual].

"In Persia the fresh shoots of the schabdar are also used for salad. The flowers are visited by bees."

26136. GOSSYPIUM BARBADENSE L. **Cotton.**

From Nyassaland Protectorate, British Central Africa. Presented by Mr. J. Stewart J. McCall, director of agriculture, Zomba. Received October 23, 1909.

"*Egyptian* (*Abbasi*). Our Egyptian is not nearly so good as our Upland cotton (S. P. I. No. 25964)." (*McCall.*)

26137. FRAGARIA sp. **Strawberry.**

From Germany. Presented by Rev. J. M. W. Farnham, Chinese Tract Society, Shanghai, China. Received September 13, 1909

White fruited. (Seed.)

26138 to 26140. RIBES hybrids. **Gooseberry.**

From Little Silver, N. J. Presented by Dr. W. Van Fleet. Received October 22, 1909.

Plants of the following; quoted notes by Doctor Van Fleet:

26138. RIBES MISSOURIENSE × RECLINATUM.

"Third generation. (*R. gracile* (*R. missouriense*) × *Red Warrington* × *Triumph* × *Keepsake.*) Six-year-old plant, very vigorous, 6 feet high, disease-resistant foliage, productive, berries dark reddish-purple when ripe, smooth, thin skinned, larger than Houghton, excellent quality, seeds small."

26139. RIBES CYNOSBATI × RECLINATUM.

"Second generation. (*R. cynosbati* × *Triumph* × *Whitesmith.*) Fair grower; rather spreading; good, disease-resistant foliage; berries large, dark red when ripe, few soft spines, very firm, agreeable flavor, small seeds; excellent for jelly."

26140. RIBES ROTUNDIFOLIUM × RECLINATUM.

"Third generation. (*R. rotundifolium* × *Houghton* × *Triumph* × *Keepsake.*) Healthy, upright grower; disease-resistant foliage; berries rather small, smooth, bright red when ripe, brisk, pleasant quality, exceedingly productive."

"These hybrids are final selections from hundreds of seedlings, representing 12 years of arduous work."

NOTE.—"Houghton is supposed to be *R. oxycanthoides* × *grossularia* (*reclinatum*)."

26141 and 26142.

From Pretoria, Transvaal, South Africa. Presented by Mr. F. T. Nicholson, secretary, Transvaal Agricultural Union. Received October 25, 1909.

26141. VICIA FABA L. **Horse bean.**

Light brown seeded. (Seed.)

26142. GLADIOLUS sp. (Bulbs.)

26143 and 26144.

From the Himalayas, India. Presented by J. Mollison, esq., Inspector-General of Agriculture in India. Received October 26, 1909.

Seeds of the following:

26143. MALUS SYLVESTRIS Mill. **Crab apple.**

"*Pala* (*Palu*) is generally propagated by cuttings. When grown from seeds, the method of raising the plants is as follows: In the month of January, the plat to be sown is dug about one-half foot deep and is manured. Then the seeds are sown and germinate in the following summer.

"In January next (i. e., a year after), the plants are transplanted, where desired, in pits dug for that purpose. Pala is only grafted on seb (apple). It is also grafted with nashpati (pears), but the pears produced are sour." (*Mollison.*)

26144. PRUNUS PADUS L.

"*Jamu.* The process of cultivating jamu is the same as that of pala (S. P. I. No. 26143).

"This plant is grafted with aloocha (plum) (S. P. I. No. 26049) and yields aloocha fruit. If it is grafted on aloocha plant, jamu fruits will be produced." (*Mollison.*)

26145 and 26146. ANDROPOGON SORGHUM (L.) Brot. Durra.

From Igatpuri, India. Presented by Mrs. Effie Pyle Fisher, through Miss Audrey Goss. Received August 31, 1909.

Seeds of the following; notes by Mr. Carleton R. Ball:

26145. "Apparently very similar to No. 9856, Dagdi durra, which we are selecting for grain production, and which now gives considerable promise of value for the Southwest."

26146. "A white durra with black hulls, probably a late sort."

26147. CITRUS AURANTIUM SINENSIS L. Orange.

From Mount Gravatt, Brisbane, Australia. Presented by Mr. John Williams. Received October 28, 1909.

"*Usher's Favorite.* It ripens in October here, and is a splendid keeper; quality, flavor, and all things considered, I believe it to be really first class." (*Williams.*)

(Plants.)

26148 to 26155. ANONA CHERIMOLA Mill. Cherimoyer.

From Santa Inez, Chile. Presented by Mr. Salvador Izquierdo. Received October 26, 1909.

"Nos. 26148, 26152, 26153, 26154, and 26155 are different cherimolas with very large fruits, of the form 'ananas.' No. 26149 is a very large cherimolia with smooth skin. Nos. 26150 and 26151 are large-fruited cherimolias, smooth skin, form 'concha.'" (*Izquierdo.*) (Cuttings.)

26156 to 26160.

From Foochow, China. Presented by Mr. Samuel L. Gracey, American consul. Received October 25, 1909.

Seeds of the following:

26156 to 26158. CITRULLUS VULGARIS Schrad. **Watermelon.**

26156. "White or Shanghai melon, very popular in this district." (*Gracey.*)

26156 to 26160—Continued.

26156 to 26158—Continued.

26157. Yellow. **26158.** Red.

26159 and 26160. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

26159. Yellow seeded. **26160.** Green seeded.

26161. MEDICAGO SATIVA L. **Alfalfa.**

From different oases in the region of Ourlana and Tougourt, Algeria. Purchased from M. Colombo, père, Biskra, Algeria, at the request of Mr. Walter T. Swingle. Received October 29, 1909.

26162 to 26178.

Presented to Mr. P. J. Wester, Subtropical Garden, Miami, Fla., and turned over by him to this office for distribution, October, 1909.

Seeds (unless otherwise noted) were received of the following; notes by Mr. Wester:

26162 to 26174. Presented by Mr. J. M. Doctor, acting superintendent, Victoria Gardens, Bombay, India.

26162. ACACIA ARABICA (Lam.) Willd.

"The gum arabic. An evergreen shade tree with dense and spreading crown, attaining a height of 60 feet; valuable for its gum, bark, and timber; the pods are a favorite food for sheep and goats. The tree thrives on a great variety of soils and is resistant to droughts."

Distribution.—Widely distributed, being found in India, Ceylon, Egypt, Arabia, tropical Africa, and Natal.

26163. ACACIA sp.

26164. BARRINGTONIA ASIATICA (L.) Kurz.

"An ornamental, lecythidaceous, evergreen shrub, attaining a height of 6 to 8 feet; cultivated as an ornamental on account of its shining foliage and large, handsome purple and white flowers produced on an erect thyrse."

Distribution.—Found along the shores of southern India, and of Australia, and on the islands between.

26165. BAUHINIA ACUMINATA L.

"A leguminous ornamental shrub, 6 to 8 feet tall, native of Malabar, bearing white flowers."

Distribution.—India, especially in the northwestern part, and extending to Ceylon, China, and the Malayan Islands.

26166. THESPESIA LAMPAS (Cav.) Dalz. and Gibs.

Distribution.—The tropical Himalayas of India, from Kumaon eastward, and in Bengal, Burma, and Ceylon; also found in Java and in eastern tropical Africa.

26167. BUTEA MONOSPERMA (Lam.) Taub.

"Leguminous, native of India. An ornamental shade tree with dense foliage, attaining a height of 40 to 50 feet. The flowers are very showy, crimson, 2 inches long."

Distribution.—Found throughout the plains of India, from the Himalayas to Ceylon and Burma.

26162 to 26178—Continued.

26162 to 26174—Continued.

26168. Cassia auriculata L.

"A shrub or small tree, native of India, the bark of which yields tannin. In young plants the bark has been found to contain 11.92 tannin and 22.35 extract; in old plants the corresponding figures are 20.12 and 29. In India the leaves are used as a substitute for tea and eaten as a vegetable in times of famine. This is also cultivated for its ornamental value. The yellow flowers appear in June and July."

Distribution.—Wild in the western and central part of India and in Ceylon; often cultivated in the Tropics.

26169. Cassia glauca Lam.

"A tall leguminous tree."

Distribution.—From the Himalayas, in India, through Ceylon and the Polynesian Islands to Australia.

26170. Cassia grandis L. f.

"A tree attaining a height of 45 to 55 feet furnishes a very handsome fine-grained wood. A dense shade tree, flowers very handsome, appearing in April."

Distribution.—The northern part of South America, from Panama, through Colombia and Guiana, to Brazil; also found in the West Indies.

26171. Caesalpinia coriaria (Jacq.) Willd.

See Nos. 23335 and 25281 for previous introductions.

26172. Pithecolobium dulce (Roxb.) Benth.

"A tree of very rapid growth, deserving wider distribution." See No. 23457 for description.

26173. Ficus benghalensis L. **Banyan tree.**

"In tropical India and Africa this tree attains a height of 70 to 100 feet. The aerial roots descending from the branches form accessory trunks, thus extending the growth of the tree from the main stem. The leaves are eaten by cattle. In India the fruits are eaten in time of famine. The wood, if carefully cut and seasoned, can be made into furniture and is sometimes employed in making boxes and door panels. The Hindoos regard the tree as sacred. The one tree in southern Florida that has come to my attention does so exceedingly well that the species deserves wider distribution."

Distribution.—Found wild in the lower Himalayan forests and on the Deccan hills; cultivated throughout India on the plains.

26174. Ficus cannonii (Bull.) N. E. Brown.

"An ornamental-leaved greenhouse plant from the Society Islands. With the exception of the cultivated fig all species of Ficus introduced to southern Florida, as far as they have come to my attention, do so exceedingly well that I have thought it well worth while to introduce all species that are cultivated in other parts of the world in the hope of finding a suitable stock for the fig, which does not do well on its own roots here, largely on account of root-knot."

26175 to 26178. Presented by Mr. A. S. Archer, Antigua, British West Indies.

26175. Thryalis glauca (Cav.) Kuntz.

"An ornamental shrub bearing yellow flowers, Malpighiaceae."

26162 to 26178—Continued.

26175 to 26178—Continued.

Distribution.—Mexico and Central America, from Sierra Madre and Zacatecas, south to Nicaragua.

26176. HAEMATOXYLUM CAMPECHIANUM L. **Logwood.**

"Leguminous. The tree furnishes the logwood of commerce and the wood may be utilized in turning. The honey produced from the flowers of this species is said to be the finest in the world. The tree attains a height of 30 to 45 feet."

Distribution.—Central America, from Tehuantepec and Yucatan to Nicaragua and Colombia; also West Indies.

26177. BOUSSINGAULTIA BASELLOIDES H. B. K.

"A rapid-growing half-hardy ornamental climber. The flowers on opening are white and fragrant, turning black before withering. Easily propagated from tubers growing on the stem."

Distribution.—Southern Mexico and South America, from Gonacatepec south to southern Brazil.

26178. CEDRELA ODORATA L.

"Indigenous to the West Indies; attains a height of 80 feet. The wood is light, of pleasant odor, and easily worked, preferentially chosen in its native country for cigar boxes and a variety of other articles; also furniture."

26179 to 26182.

From Tripoli, in Barbary, North Africa. Presented by Mr. William Coffin, American consul. Received October 28 and November 1, 1909.

Seeds of the following; descriptive notes by Mr. Coffin:

26179. HORDEUM VULGARE L. **Barley.**

Dry land.

26180. PENNISETUM AMERICANUM (L.) Schum. **Pearl millet.**

"*Kassab.* The Arabs think very highly of this grain as a food and use the grass as fodder for their stock."

26181. MEDICAGO SATIVA L. **Alfalfa.**

"*Safsafa* or *Susfa.* Sometimes they get eight crops of this in the eight months of the year it grows. I have seen at least five, and I think six, crops harvested from fields just back of my house. They irrigate about every four days."

26182. CITRUS AURANTIUM SINENSIS L. **Orange.**

Blood flesh. (Plants.)

26183. STIZOLOBIUM sp.

From Sibpur, near Calcutta, India. Presented by Maj. A. T. Gage, director, Royal Botanic Garden. Received November 2, 1909.

Black seeded.

26184. FUNTUMIA ELASTICA (Preuss) Stapf.

Presented by Mr. Gilbert Christy, F. L. S., care of Thomas Christy & Co., 4, 10, and 12 Old Swan lane, Upper Thames street, E. C., London, England. Received December 2, 1909.

"Seeds of a very large forest tree. I suggest that you have them planted in one of the Cuban stations. It would be necessary to shade the growing seedlings in the summer, otherwise they would be likely to dry off." (*Christy.*)

26184—Continued.

Distribution.—Along the west coast of Africa from the Gold Coast in Ashanti through Lagos and lower Nigeria to the valley of Mungo River; usually in forests and along streams.

26185. STIZOLOBIUM sp.

From Tehwa, via Foochow, China. Presented by Miss Jessie A. Marriott. Received December 3, 1909.

"This species has pods about intermediate in character between the Lyon bean, No. 19979, and the Yokohama, No. 25254. To judge from its behavior in the greenhouse, it is about intermediate in time of maturity between these two species. The flowers are white as in the Lyon bean; very similar to the Japanese variety." (*C. V. Piper.*)

26186 and 26187.

From Nice, France. Presented by Dr. A. Robertson Proschowsky. Received November 2, 1909.

26186. FURCRAEA BEDINGHOUSI K. Koch.

"This plant is said (like most Furcraea, I suppose) to produce good fibers. This species is hardier than any other Furcraea I cultivate or know, and has once resisted from 5 to 7 degrees below zero Centigrade, without suffering the least. A few seeds were also produced on the 6-meter-high flower stalk." (*Proschowsky.*)

Distribution.—On the slopes of Acusca Mountain, south of the city of Mexico, at an elevation of about 12,000 feet. (Bulbs.)

26187. MAYTENUS BOARIA Molina.

See No. 3394 for description.

Distribution.—Dry lowlands along the coast of Chili and southward into Patagonia. (Seeds.)

26188. KAEMPFERIA sp. **"Sherungulu."**

From Transvaal, South Africa. Presented by Prof. J. Burtt Davy, government agrostologist and botanist, Transvaal Department of Agriculture, Pretoria. Received November 5, 1909.

"This plant grows in tropical and subtropical Transvaal and the tubers or rhizomes are dried and sent up from the Low Country, for sale to natives working on the Witwatersrand, by whom they are supposed to have medicinal or other virtues.

"It has been suggested that owing to the remarkable fragrance of the tubers, they might possibly be of use in the perfume trade for scenting tooth powders, soaps, etc.

"The flowers are distinctly ornamental." (*Davy.*) (Tubers.)

26189. CHRYSANTHEMUM HYBRIDUM Hort. **Shasta daisy.**

From Rosedale, Santa Cruz, California. Presented by Mr. George J. Streator. Received November 4, 1909.

"Streator's strain of the so-called Shasta daisy. Seed from the finest semidouble, quilled, fimbriated, or fringed forms." (*Streator.*)

26193 to 26195.

From Mexico. Procured by Dr. David Griffiths, Agriculturist, of this Department. Received November 5, 1909.

26193 to 26195—Continued.

Seeds of each of the following:

26193 and 26194. Cicer arietinum L. **Chick-pea.**

26193. Small seeded. **26194.** Large seeded.

26195. Physalis ixocarpa Brot. **Husk tomato.**

"This big blue husk tomato is often 4 centimeters in diameter, as found upon the markets of Oaxaca and Mexico City especially."

Distribution.—Found wild in California, Colorado, New Mexico, Texas, Mexico, and Cuba; cultivated, and often escaped, as far north as Massachusetts, Michigan, Dakota, Oregon, and Washington.

26196. Saccharum officinarum L. Sugar cane.

From Honolulu, Hawaii. Presented by Mr. Harold L. Lyon, Experiment Station of the Hawaiian Sugar Planters' Association. Received November 2, 1909.

Lahina. "This cane has proved itself to be the best money maker that Hawaii ever saw. Under irrigation it is a splendid cane if the conditions are suited. Unfortunately it is a cane that is very subject to disease. In those parts of Hawaii where it can still be used, namely, those parts where the sky is nearly cloudless the year around and the rainfall very slight, it still does better than any other cane. If any attempt to introduce this cane to other places from Hawaii is made, great care should be exercised to select cuttings free from disease." (*N. A. Cobb, letter of May 22, 1909.*) (Cuttings.)

26197 and 26198. Rubus spp.

From Enfield, England. Purchased from Messrs. Stuart Low & Co., Royal Nurseries, Bush Hill Park, at the request of Mr. Walter T. Swingle. Received November 4, 1909.

Plants of the following:

26197.

"*Lowberry.* This is said to be as large as the loganberry and to be as strong a grower, and to be 'altogether the most valuable novelty in the fruit way produced for some years.'" (*Swingle.*)

26198.

"*Low's Phenomenal.* A raspberry-loganberry hybrid, 'possessing all the flavor of the raspberry, and combining the free fruiting qualities of this now famous berry.'" (*Swingle.*)

26199. (Undetermined.)

From Standerton, Transvaal. Presented by Mr. O. W. Barrett, director of agriculture, Lourenço Marquez, Portuguese East Africa. Received November 8, 1909.

"Seeds of a striking asclepiad. This vine is probably native to the locality. Foliage not seen. Stems, thickish, green. Fruits (follicles) about 4 inches long, opening to about 3 inches wide. Ornamental and ought to make a good trellis or porch vine for the Southern States and California." (*Barrett.*)

26200. Lolium strictum Presl.

From Sfax, Tunis. Presented by Doctor Trabut, Algiers, Algeria. Received November 8, 1909.

"Seed of ray-grass, native name *maudjour*. Excellent forage; grows in arid regions; annual; interesting to cultivate in the steppes." (*Trabut.*)

26200—Continued.

Distribution.—The countries bordering on the Mediterranean Sea and the Canary Islands.

26201 and 26202.

From 30 miles north of Hangchow, China. Presented by Rev. J. M. W. Farnham, Presbyterian Mission, Shanghai, China. Received November 2, 1909.

Seeds of the following:

26201. CUCUMIS MELO L. **Muskmelon.**

Golden.

26202. SILENE sp. **Wild pink.**

"Found on the mountain here." (*Farnham.*)

26203 to 26206.

Presented by Mr. H. F. Schultz, Ancon, Canal Zone, Panama. Received November 9, 1909.

26203. ANONA SQUAMOSA L.

From David, Chiriqui, Panama. "Seed from a tree bearing large and very superior fruits of fine flavor." (*Schultz.*)

26204. ARRACACIA sp. **"Aracache."**

From Boquete, Chiriqui, Panama. "Tubers of a plant found growing in the neighborhood of Boquete in a cultivated and semicultivated state. The tubers grow to a size of 6 to 15 inches in length and about 6 to 8 inches in diameter, weighing from 2 to 10 pounds. The foliage resembles somewhat that of celery, and it grows to a height of about 10 to 18 inches above the ground. The taste of the root resembles a cross between a potato, celery, and asparagus, and it is eaten like potatoes, roasted, baked, or fried, as well as cut up in soups. I have found it growing at an altitude of 3,000 to 5,000 feet above sea level, and the inhabitants claim that it will not grow on the lower levels. I think, however, that it will do well in the Gulf States and that it will prove valuable, as I know that it is a well-flavored vegetable." (*Schultz.*)

See S. P. I. No. 3511 for previous introduction.

26205. BYRSONIMA COTINIFOLIA H. B. K.

From Chiriqui, Panama. "Seeds of a fruit called 'Nance' which is used by the inhabitants as the main ingredient for a cooling and very pleasing drink. This tree is found growing at all altitudes from sea level up to about 4,000 feet and above. I do not think that it is a very valuable tree. It may possibly succeed in southern California." (*Schultz.*)

Distribution.—Along the Pacific coast of Mexico, from the province of Tepic to Chiapas.

26206. PARMENTIERA CEREIFERA Seem.

From Bugaba, Panama. "Seed of an ornamental tree with peculiarly shaped candle-like fruits produced in great abundance on the second year's growth of the plant. The long, smooth, yellow fruits are 8 to 20 inches long and one-half to three-fourths of an inch in diameter, containing in the strong, fibrous, fleshy pulp numerous small flat seeds. The inside of the fruit has a strong musky fragrance, and the appearance of the bushy, spreading shrub, which grows to a height of about 12 to 15 feet, with its numerous candle-like fruits, is quite odd. The fruits were obtained on the ranch of Mr. Alexander Croetsch, of Bugaba, province of Chiriqui, and flowers were not in evidence." (*Schultz.*)

Distribution.—Confined to the valley of Chagres River, Republic of Panama.

26207. PROTEA MELLIFERA Thunb.

From Durban, Natal, South Africa. Presented by Prof. J. Medley Wood, director, Botanic Gardens. Received November 8, 1909.

A South African bush, useful both as an ornamental and as a bee plant.

26208. SOLANUM TUBEROSUM L. **Potato.**

From Solomon, Alaska. Presented by Mr. T. Brown. Received October 14, 1909.

"Tubers round to oblong, flattened; skin deep flesh color; eyes few and shallow." (*W. V. Shear.*)

26209 to 26223. CITRUS spp.

From Sawbridgeworth, Herts, England. Purchased from Thomas Rivers & Son, at the request of Mr. Walter T. Swingle. Received November 11, 1909.

Plants of the following:

26209 to 26219. CITRUS AURANTIUM SINENSIS L. **Orange.**

26209 to 26216. Subvarieties of the St. Michael's orange, which is said to be the ordinary orange of commerce, and although some of the strains have been tried in this country it was thought desirable to introduce the following:

26209. *Long.*
26210. *Botelha.*
26211. *Bittencourt.*
26212. *Nonpareil.*
26213. *Dom Louise.*
26214. *Egg.*
26215. *Excelsior.*
26216. *Dulcissima.*

26217. *White.* "Very distinct, with striped fruit and white pulp; flavor very good." (*T. Rivers & Son.*)

26218. *Embigus* (Navel).

"A singular variety, with a nipple-like excrescence at the apex; fruit large and good; pulp pale in color." (*T. Rivers & Son.*)

26219. *Silver* (Plata). "A delicious orange." (*T. Rivers & Son.*)

26220 and 26221. CITRUS LIMETTA Risso. **Lime.**

26220. *Common.* "An abundant bearer; fruit excellent for cooling drinks." (*T. Rivers & Son.*)

26221. *Bitter.* "Remarkable for the great fertility and dwarf habit of the tree; resembles the Bijou lemon so closely as to be distinguished with difficulty except by the color of its fruit." (*T. Rivers & Son.*) See No. 26222.

26222 and 26223. CITRUS LIMONUM Risso. **Lemon.**

26222. *Bijou.* "Pronounced to be a lime by some authorities. Fruit small, with a delicious aroma; growth of the tree very dwarf and fruitful; this is a remarkable sort." (*T. Rivers & Son.*) See No. 26221.

26223. *White.* "One of the largest and best." (*T. Rivers & Son.*)

26224. CARICA PAPAYA L. **Papaw.**

From Puerto Plata, Dominican Republic. Presented by Mr. A. W. Lithgow, American vice-consul. Received November 12, 1909.

"Native name 'lechosa,' the only class known here." (*Lithgow.*) (Seeds.)

26225 to 26227. CITRULLUS VULGARIS Schrad. **Watermelon.**

From Bucharest, Roumania. Presented by Mr. William G. Boxshall, vice consul-general, through Mr. Horace G. Knowles. Received November 13, 1909.

Seed of the following small melons:

26225. Red flesh.
26226. Yellow flesh.
26227. Red flesh.

26228 and 26229. AVENA SATIVA L. **Oat.**

From Feuchtwangen, Germany. Purchased from Mrs. Sophie Kreiselmeyer. Received April 20, 1909. Numbered for convenience in recording distribution November 15, 1909, at which time definite information regarding this shipment was received.

Seed of the following:

26228. *Giant of Ligowa.*
26229. *Fichtelgebirge.*

26230 to 26235. CASTANEA hybrids.

From Little Silver, N. J. Presented by Dr. W. Van Fleet. Received October, 1909.

26230 and 26231. CASTANEA PUMILA × CRENATA.

"Mostly shrubby in habit; good growers; nuts twice as large as *C. pumila*, often three in a bur; productive, and bears at two to three years from seed. Supposed to be resistant to bark disease." (*Van Fleet.*)

26230. (Seeds.)
26231. (Plants.)

26232 and 26233. CASTANEA PUMILA × SATIVA (*Paragon* variety).

"Nuts four times as large as those of *C. pumila*, sometimes three in a bur; good growers; arborescent; productive and bears at six years from seed." (*Van Fleet.*)

26232. (Plants.)
26233. (Seeds.)

26234 and 26235. CASTANEA PUMILA × CRENATA.

"Second generation from self-pollinated seeds; vigorous; not fruited; supposed to be resistant to bark disease." (*Van Fleet.*)

26234. Arborescent plant.
26235. Shrubby plant.

26236 and 26237. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

From Cedara, Natal, South Africa. Presented by Mr. E. R. Sawer, director, Division of Agriculture and Forestry. Received November 12, 1909.

Seeds of the following:

26236. "Mammoth yellow."
26237. "Chinese," yellow.

"This is our principal field crop in the Midlands." (*Sawer.*)

26238 to 26240. RUBUS spp.

From Lowdham, Nottinghamshire, England. Purchased from Messrs. J. R. Pearson & Sons, at the request of Mr. Walter T. Swingle. Received November 16, 1909.

Plants of the following:

26238. **Blackberry.**

Parsley leaved. "This is said to be of English origin, supposed to have originated at Handsworth, and is, in the opinion of Messrs. Pearson & Sons, 'far

26238 to 26240—Continued.

26238—Continued.

better than any of the American kinds, and in addition to being a good cropper, it is very ornamental and may be used with good effect for covering wild rockery and rough banks.'" (*Swingle.*)

26239. **Raspberry.**

November Abundance. "This is said to produce 'a good supply of fruit during September and onwards.'" (*Swingle.*)

26240. **Raspberry.**

Superlative. "Said to be a good dessert berry, of red color, large size, and of excellent flavor, readily picked on account of its long stalks." (*Swingle.*)

26241. Brassica oleracea capitata L. **Cabbage.**

From Dalny, Manchuria. Presented by Mr. A. A. Williamson, vice-consul in charge. Received November 15, 1909.

"The Manchurian cabbage is one of the chief articles of diet of the inhabitants of these regions. It is particularly tender, succulent, and well flavored. These are a few of the first seeds, which only ripen in the spring." (*Williamson.*)

26242. Quercus aegilops L. **Oak.**

From Patras, Greece. Presented by Hon. F. B. Wood, British consul. Received November 16, 1909.

Valonia. "The valonia oak derives its name from a Greek word signifying acorn. The valonia produces fully two or three times more than the ordinary oak. The term 'valonia' used commercially does not apply to the acorn but to the cup which contains it, which when ground is used for tanning purposes. The cup is a bright drab color, which it preserves as long as it is kept dry; any dampness injures it, as it then turns black and loses both its strength and value. The more substance or thickness there is in the husk or cup the better it is for commercial purposes.

"Valonia without the acorn (which is only of use for feeding swine, etc.) is worth about £8 to £10 per ton, but the finer quality sometimes fetches £2 or £3 more. In former years the article was worth double the above figures, but chemical and other substitutes used for tanning purposes have brought its value down to a point which scarcely covers the expense of picking and getting ready for shipment.

"The valonia oak flourishes almost exclusively in the Levant; Greece, several islands in the Aegean Sea, Crete, and Asia Minor are its favorite localities. There it thrives in great profusion and in every variety of soil and climate, being affected by neither severe heat nor great cold. In the plains of Elis in soft, heavy, rich soil the valonia displays all its beauties, and in perfect similarity to its congener growing on the barren and stony mountains of Acarnania and Laconia.

"The tree is very beautiful with its great outspreading branches and delicate foliage; it reaches in many instances a height of 60 feet and a girth of 15 feet 3 or 4 feet from the soil. In appearance it resembles the ordinary oak and has many of the latter's characteristics, forming occasionally great distorted boles. It produces the oak apple, and the mistletoe grows on it plentifully.

"The valonia tree can scarcely be called deciduous, for although the leaves attain a withered and brownish look in winter, only a certain proportion are cast before the fresh shoots appear in the early spring.

"The finest valonia forest I know of exists in the province of Achaia, between Patras and Pyrgos. In length it measures some 10 miles and in breadth about 4 or 5. The trees in most instances must be several centuries old.

"The manner of collecting valonia brings one back almost to patriarchal days. The Greek peasantry are for the most part and to a great extent nomadic. In the

26242—Continued.

summer and spring months they retire to their mountain villages, but in winter, driven down by the snows, they descend into the plains bordering the sea and live as squatters. Each family has acquired hereditary rights for years and years to occupy certain portions of the plains, paying a head tax for the cattle which accompany it and having a right to collect valonia in a certain area. The old patriarch of the family, with his wife, sons, daughters, and grandchildren may be seen collecting valonia, for which they pay a tax of 10 per cent in kind to the owner of the property.

"In 1899 the production of valonia in the different localities was as follows: 5,000 tons in Acarnania and Aetolia; 4,100 tons in Laconia and Arcadia; and 900 tons in Achaia. In 1908 the total product of Greece had diminished to 4,000 tons." (*Wood.*)

"Valonia consists of the acorn cups, the best of which contain about 40 per cent of tannin. It is especially serviceable in the production of heavy leathers. The tree has been grown in the vicinity of Paris, where it attained an age of 25 to 28 years before bearing fruit. In the collection of valonia the labor of children and young girls is said to be largely used, the pay of the most skillful amounting to about 30 cents per day." (*W. W. Stockberger.*)

Distribution.—Lower mountain slopes and valleys of Greece, and on the Cyclades. See No. 6833 for previous introduction.

26243. GARCINIA BRASILIENSIS Mart. (?).

From Lawang, Java. Presented by Mr. M. Buysman, Hortus Tenggerensis. Received November 19, 1909.

Distribution.—Found in the woods in the province of Para, in the northern part of Brazil. (Seed.)

26244 and 26245. POLAKOWSKIA TACACO Pittier.

From San José, Costa Rica. Presented by Mr. Ad. Tonduz, through Prof. H. Pittier. Received November 19, 1909.

26244. Small variety having fiber. **26245.** Large variety without fiber.

"A cucurbitaceous plant, the fruit of which is used as a green vegetable. It is a near relative to the chayote, but the fruit is smaller, fusiform, set with stiff spines at the base and of quite a distinct taste. It is one of the primitive foods of the native Indians of Costa Rica, where it grows wild in fresh, shady places of the temperate region, and its use as a vegetable has been readily adopted by the Spanish Costa Ricans. Nowadays the plant is at least semicultivated on the central plateau. To grow it, a whole mature fruit is set in a rich, loose leaf mold with the spiny end up and almost showing at the surface. The vines spread on the ground or on low bushes or supports. The fruits, which are about 2½ inches long and 1½ inches broad, hang from short peduncles and are picked when still green. After taking away the basal spines they are boiled in water, either whole or cut into small pieces, or pickled, or made into preserves. They are also a favorite addition to the native vegetable soups." (*H. Pittier.*)

26246 to 26252. PRUNUS spp. **Cherry.**

From western Hupeh, China. Purchased from Mr. C. S. Sargent, director of the Arnold Arboretum, Jamaica Plain, Mass. Received November 22, 1909.

Plants of the following; notes by Mr. E. H. Wilson:

26246. From Changyang Hsien. "(A. A. No. 3.) A very ornamental tree, attaining a height of 10 to 30 feet. Grows on mountains at an alititude of 2,500 to 3,500 feet. Flowers white."

26246 to 26252—Continued.

26247. From Changyang Hsien. "(A. A. No. 3a.) A very ornamental tree, attaining a height of 10 to 30 feet. Grows on mountains at an altitude of 2,500 to 3,500 feet. Flowers white."

26248. From north and south of Ichang. "(A. A. No. 3b.) A very ornamental tree, attaining a height of 10 to 30 feet. Grows on mountains at an altitude of 2,500 to 3,500 feet. Flowers white."

26249. "(A. A. No. 4.) No description.

26250. From Changyang Hsien. "(A. A. No. 5.) A rare and magnificent species, attaining a height of 35 feet. Grows in glades at an altitude of 3,500 feet. Fruit black."

26251. From Changyang Hsien. "(A. A. No. 7.) A very fine tree, rare, attaining a height of 25 to 35 feet. Grows in woods at an altitude of 3,000 to 3,500 feet. Flowers pink."

26252. From Changyang Hsien. "(A. A. No. 11.) A very common bush species, growing 10 feet high in mountains at an altitude of 2,500 to 3,500 feet. Flowers white and pink."

26253. VICIA FABA L. **Horse bean.**

From Kindred, N. Dak. Presented by Mr. A. P. Hertsgaard. Received November 22, 1909.

"Grown in North Dakota, summer of 1909. Seed originally from Holland. This is said to be called in Holland the pigeon pea." (*Hertsgaard.*)

26256 to 26259. EUCALYPTUS spp.

From Sydney, New South Wales, Australia. Procured from Mr. J. H. Maiden, director and government botanist, Botanic Gardens. Received November 25, 1909.

Seed of each of the following procured for planting on the experimental plantation to be established by the Forest Service, in cooperation with the Bureau of Plant Industry, at Brownsville, Tex.:

26256. EUCALYPTUS SIDEROXYLON A. Cunn.

Distribution.—Australia, in the provinces of New South Wales, Victoria, and South Australia.

26257. EUCALYPTUS GONIOCALYX F. Muell.

Distribution.—Southeastern Australia, from Twofold Bay in New South Wales, to the Buffalo Range in Victoria.

26258. EUCALYPTUS BOTRYOIDES Smith.

Distribution.—Eastern Australia, from Brisbane in Queensland, south through New South Wales, to Victoria.

26259. EUCALYPTUS PAUCIFLORA Sieber.

Distribution.—Common in Tasmania, and in South Australia, Victoria, and New South Wales.

26265. ROSA CANINA L. **Rose.**

From Mexico. Presented by Mr. Harvey C. Stiles, Mexico City, through Mr. P. J. Wester. Received November 26, 1909.

"Seeds of a wild rose, native of the cool, frostless Mexican highlands, but found only where there is constant moisture; it grows luxuriantly, often 12 to 20 feet high, and I have sometimes seen it in gardens, budded or grafted to other sorts of fine roses. It makes an ideal stock, not sprouting like *Manetti*, etc." (*Stiles.*)

26266 and 26267.

From Cape Town, South Africa. Presented by Mr. R. W. Thornton, government agriculturist, Department of Agriculture. Received November 23, 1909.

Seed of the following:

26266. Pentzia incana (Thunb.) Kuntze. **"Karroo bush."**

Distribution.—Eastern South Africa, from Natal south to Uitenhage, Cape Colony.

26267. Panicum sp.

"This is an indigenous grass which is considered to be one of the best grasses in the Orange River Colony, where in certain parts it is practically the only fodder which the stock have." (*Thornton.*)

26268 and 26269. Passiflora spp.

From Port of Spain, Trinidad. Presented by Dr. E. André. Received November 27, 1909.

Seeds of the following:

26268. Passiflora quadrangularis L. **Granadilla.**

"A plant of South American origin very closely allied to *Passiflora macrocarpa* and *P. alata*, now cultivated in many tropical countries. Its large, greenish-yellow fruit has a thick rind which is sometimes preserved, and the pulp surrounding its seeds, though sometimes insipid, is usually pleasant flavored and is made into cooling drinks and sherbets. The seeds are too large to be swallowed as in the case of the smaller fruited species. This plant is valuable for covering arbors and verandas. The leaves are large, membranaceous, and heart shaped; the large fragrant flowers have red petals alternating with the white sepals, while in the closely allied *P. macrocarpa* both the sepals and petals are purplish. Many species of Passiflora are incorrectly referred to this species." (*W. E. Safford.*)

26269. Passiflora maliformis L. **Sweet cup.**

"This species is frequently cultivated in the West Indies, and on some of the islands it is found wild. The fruit is globose, or apple shaped, and much smaller than the Granadilla or Barbadine (S. P. I. No. 26268). It has a thin shell-like envelope, not soft like that of the waterlemon (*P. laurifolia*) but varying in rigidity. In the specimens sent the shell, which is yellow and marked with numerous white dots, is easily indented, almost like that of *P. ligularis*, but in some varieties it is hard and rigid, even sufficiently so that snuffboxes can be made of it. The pulp is pleasant flavored and slightly acidulous, and the seeds are small enough to swallow. The leaves are simple, entire, and oval or ovate, with linear lanceolate stipules and petioles bearing two glands. The flowers are sweet scented and beautiful, variegated red and white, with blue coronal filaments." (*W. E. Safford.*)

26270 to 26278. Rubus spp.

From western Hupeh, China. Purchased from Prof. C. S. Sargent, director, Arnold Arboretum, Jamaica Plain, Mass. Received November 29, 1909.

Plants of the following; notes by Mr. E. H. Wilson:

26270. Rubus bambusarum Focke.

From north and south of Ichang. "(A. A. No. 48.) A straggling plant; height 10 to 15 feet. Grows in thickets at an elevation of 3,000 to 5,000 feet. Flowers pink. A fine Rubus."

26270 to 26278—Continued.

Distribution.—Bamboo forests on the mountain slopes, at an elevation of 4,000 to 6,000 feet, in the province of Hupeh, central China.

26271. RUBUS INNOMINATUS S. Moore.

From north and south of Ichang. "(A. A. No. 92.) A shrubby plant; height 3 to 5 feet. Grows in thickets at an elevation of 3,000 to 4,500 feet. Pinkish flowers. Fine, red paniculate fruits."

Distribution.—The valley of the Yangtze River at Kiukiang, in the province of Kiangsi, central China.

26272. RUBUS ICHANGENSIS Hemsl. and Kuntze.

From north and south of Ichang. "(A. A. No. 663.) A straggling plant. Grows in thickets at an elevation of 2,000 to 4,000 feet. Flowers white. A good thing."

Distribution.—The vicinity of Ichang, province of Hupeh, China.

26273. RUBUS PARKERI Hance.

From north and south of Ichang. "(A. A. No. 44a.) A straggling plant; height 6 to 15 feet. Grows in glens, etc., up to an elevation of 2,000 feet. Pink flowers, calyx red, very glandular."

Distribution.—The provinces of Hupeh and Szechwan, China.

26274. RUBUS LAMBERTIANUS Ser.

From north and south of Ichang. "(A. A. No. 482.) A spreading plant; height 6 to 10 feet. Grows in thickets at an elevation of 2,000 to 4,000 feet. Whitish flowers. Red fruits."

Distribution.—Kiukiang, in the province of Kiangsi, and along the valley of Lienchu River, in the vicinity of Saingu, province of Kwangtung, central China.

26275. RUBUS CHROOSEPALUS Focke.

From south of Ichang. "(A. A. No. 80.) A rambling plant; height 7 to 10 feet. Grows in thickets at an elevation of 3,000 to 4,000 feet. Leaves small, cordate, hairy below."

Distribution.—The vicinity of Patung, in the western part of Hupeh.

26276. RUBUS CONDUPLICATUS Duthie.

From north and south of Ichang. "(A. A. No. 97.) An erect plant; height 6 to 8 feet. Grows in thickets at an elevation of 3,000 to 5,000 feet. Flowers pink. Fruit red, growing in dense clusters."

26277. RUBUS COREANUS Miq.

From north and south of Ichang. "(A. A. No. 31.) An erect plant; height 6 to 8 feet. Grows on mountains, etc., up to an elevation of 4,000 feet. Flowers purple. Stems white. Ornamental."

Distribution.—The provinces of Kiangsi and Hupeh, in central China, and the islands of the Korean Archipelago.

26278. RUBUS HYPARGYRUS Edgew.

From Changlo Hsien. "(A. A. No. 152.) Grows on mountains at an elevation of 3,000 to 4,500 feet. Fruit dark red. Flowers paniculate. Leaves silvery below."

Distribution.—Himalaya Mountains of northeastern India and mountains of central China.

26279 to 26281.

From China. Presented by Rev. T. D. Holmes, Alfred, N. Y. Received November 24, 1909.

Seeds of the following:

26279. Aleurites fordii Hemsl. **China wood-oil tree.**

Largest seeds of this variety yet received. See No. 25081 for description.

26280. Sapindus mukorossi Gaertn.

"The Chinese use this fruit, just as it is gathered, to wash with. My wife says these soap balls are superior to our soap for washing flannel fabric, in that they prevent shrinking." (*Holmes.*)

Distribution.—Southeastern China, in the provinces of Chekiang, Fukien, Hupeh, and Kwangtung. Also in India, and introduced into Japan.

26281. Gymnocladus chinensis Baill.

"The pods of this tree are used as a soap." (*Holmes.*)

Distribution.—The southeastern part of China, in the provinces of Hupeh, Chekiang, and Kiangsi.

26282. Vicia faba L. **Horse bean.**

From Cawnpore, United Provinces, India. Presented by Mr. H. M. Leake, economic botanist to government. Received November 29, 1909.

"Seed of the only form of *Vicia faba* grown here. It is a cold-weather crop, sown in October and ripening in March. The unripe pod is used as a vegetable and the ripe seed after soaking and boiling. The stalks are used as fodder for stock, chopped up and mixed with other fodder (e. g., sorghum).

"The plant is grown only for personal consumption. It has, therefore, no market value." (*Leake.*)

26283. Pinus pinceana Gordon.

From Mexico. Presented by Mr. Elswood Chaffey, Hacienda de Cedros, Mazapil, Zacatecas, Mexico. Received November 18, 1909.

"Seed from a pine which grows some 50 feet high and as much as 2 feet in diameter." (*Chaffey.*)

Distribution.—Along gulches on the slopes of the great table-land in northeastern Mexico, between 19° and 25° north latitude.

26284 to 26288.

From Tokyo, Japan. Presented by Mr. Albert J. Perkins, who procured them from The Tokyo Plant, Seed and Implement Co. Received November 29, 1909.

Seeds of the following:

26284 to 26287. Raphanus sativus L. **Radish.**

26284. *Sakurajima.* See No. 22399 for previous introduction.

26285. *Nerima.* See No. 22397 for previous introduction.

26286. *Takuwan.*

26287. *Miyashige.*

26288. Aralia cordata Thunb. **Udo.**

Kan. For description, see Bulletin 42, Bureau of Plant Industry, Department of Agriculture.

26289 to 26291.

From Kentung, Burma. Presented by Rev. R. Harper, M. D., American Baptist Shan Mission. Received November 29, 1909.

Seeds of the following; notes by Rev. R. Harper:

26289. STIZOLOBIUM sp.

"Collected by Captain McGregor. This is a sort of creeper, I believe, very thorny."

26290. ANONA SQUAMOSA L.

"*Mak au hsa.* This fruit is a favorite in Burma, and if it can be grown in the Southern States ought to command a large market."

26291. CARICA PAPAYA L. **Papaw.**

Papaia, from which a digestive extract called papain is made.

26292 and 26293. STIZOLOBIUM spp.

From Dharapuram, India. Presented by Rev. George N. Thomssen, Baptla, South India, who procured them from Dr. C. A. Barber, government botanist, Agricultural College, Coimbatore, India. Received November 29, 1909.

Seeds of the following:

26292. "*Punarkkali.*"

26293. (Native name not given.)

"These varieties grow wild in southern India." (*Barber.*)

26294 to 26296. VICIA FABA L. **Horse bean.**

Presented by Mr. R. L. Sprague, American consul, Gibraltar, Spain. Received November 29, 1909.

Seeds of the following:

26294. From Mazagan, Morocco.

26295. From Spain.

26296. From Taragona, Spain.

26297. AMYGDALUS ANDERSONII (Gray) Greene. **Wild peach.**

From Pyramid Lake, Nevada. Presented by Mr. Marsden Manson, San Francisco, Cal. Received December 1, 1909.

Mr. Manson recommends this wild peach as a stock and for hybridizing experiments. See No. 21657 for previous introduction.

Distribution.—California, from Sierra County southward to Inyo County, and in the western part of Nevada.

26298. ANONA LONGIFLORA S. Watson.

From Altadena, Cal. Presented by Dr. F. Franceschi, Santa Barbara, Cal. Received December 1, 1909.

"Fruit said to compare well in quality with the cherimoyer. The species is hardy and grows quite vigorously at Altadena, Cal. To judge from photographs of fruit, leaves, and seeds, it would seem to be a species intermediate between *Anona cherimola* and *Anona squamosa*, possibly a natural hybrid between these species." (*P. J. Wester.*)

Distribution.—In ravines on the slopes of the Cerro de San Estevan, in the vicinity of Rio Blanco, Mexico. (Seed.)

26299. (Undetermined.) (Scrophulariaceæ.)

From Yosemite Valley, Mariposa County, Cal. Presented by Mr. F. W. McCauley, through Col. G. B. Brackett, pomologist. Received December 1, 1909.

"Seed of a wild plant that grows in this section of the country and seems to be valuable for cattle to feed on. It is a large plant, attaining a height of 3 to 4 feet and growing in the shape of a small tree. It ripens in the latter part of October, coming up the following season from seed. It is at its best for cattle in August, when it is still tender. When driven cattle throng the woods at this season of the year they will go out of their way to munch on this plant; later in the season it becomes hard and woody, and then cattle will only eat the more tender branches of it. This plant grows in light, sandy soil of granitic origin and apparently without moisture; it thrives on steep south hillsides among brush and rocks, also on the mountain top in the pine forests 4,000 feet above sea level. A peculiarity of the plant is that it grows in little patches—here half a dozen plants, and there possibly 50 together; I believe the seed does not spread readily. If this plant could be cultivated with success I believe it would be valuable as a forage plant to be grown without irrigation. It grows well at altitudes as low as 2,000 feet above sea level, where the thermometer stands at 100° and marks as high as 110°." (*McCauley.*)

26300. ROYSTONEA REGIA (H. B. K.) O. F. Cook.

From Nice, France. Presented by Dr. A. Robertson Proschowsky. Received November 27, 1909.

"A variety from Mexico." (*Proschowsky.*)

Distribution.—Common about Cruces, Gorgona, and San Juan, in Panama, and in Cuba, Antigua, and other West Indian islands.

26301. ANDROPOGON HALEPENSIS VIRGATUS Hackel.

From Algiers, Algeria. Presented by Doctor Trabut. Received December 2, 1909.

"This grass is vigorous, but not stoloniferous, and would be interesting for hybridizing with *Sorghum vulgare* [*Andropogon sorghum*]. It is a moderately good forage like Johnson grass, but has the advantage of not stooling. This variety is perennial here and produces many seeds." (*Trabut.*)

Distribution.—Egypt, extending from Alexandria, through Nubia, to the valley of the White Nile, in the Province of Kordofan.

26302 and 26303. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From Entebbe, Uganda. Presented by Mr. R. Fyffe, Botanical and Forestry Department. Received December 3, 1909.

Seeds of the following; native names as given by Mr. Fyffe:

26302. Buff seeded. (This number was assigned to three packages of seed which had been mixed in transit. The native names are as follows: "Mpendi Kiriya Mugombere," "Mpendi Kantinti," "Mpendi Bimogoti.")

26303. Black seeded. "Mpendi Luzzige."

26304 to 26329.

From Chile. Received through Mr. José D. Husbands, Limavida (via Molina), Chile, November 9, 1909.

Seeds of the following; notes by Mr. Husbands:

26304 to 26329—Continued.

26304. Acacia longifolia (Andr.) Willd.

"*Aromo.* A grand, yellow-flowered tree, grown in Chile from the time of the Spanish, for ornamental purposes."

Distribution.—A shrub or small tree found throughout Australia and in Tasmania. Used as a street tree in California.

26305. Aextoxicon punctatum R. and P.

"In Valdivia and Chiloe this plant is called 'tique' or 'palo muerto;' in the north it is called 'acietunillo' or 'olivillo.' It grows along the coast of Chile from Valparaiso to the island of Chiloe."

26306. Aristotelia macqui L'Herit.

"*El Maqui.* This is a valuable wild fruit tree and I believe is capable of improvement. The fruit is abundant, astringent, sweet, and refreshing. In time of fruitage 'chicha de maqui' is highly esteemed as a healthful beverage. It is nonfermented; the fruit is simply mashed and mixed with water and the liquid drawn off and drunk. The fruit juice is similar in color to blackberry juice; it stains whatever it comes in contact with, but it is not indelible. The fruit is gathered in immense quantities and dried for export and domestic uses, especially for coloring wines or imitating them. These seeds are from near Puerto Montt, which is the extreme southern limit of the territory allotted to their growth; they are as good as 'el maqui' of central Chile. The color of the fruit is generally a reddish black; brown, white, and pink fruits are sparsely found in a few localities, but these are different varieties. This tree sometimes attains a height of 30 to 35 feet. Usually it is not more than 12 to 15 feet high and 4 inches in diameter, but I have seen trees 16 inches in diameter. They thrive in dry central Chile, but seek the moisture of the ravines. The tree reminds one of a cherry tree. The wood is not considered. The bark of the new wood is very flexible and is used for making lassos and ropes for use about the farm; also for tying in the vineyards. The ties are strong and last a long time if dampened before using. Birds and foxes are very fond of the fruit and scatter the seeds in a fit state to germinate.

"The juice of the leaves is a splendid remedy for throat diseases and ulcers and has a fame for healing wounds. An infusion of the leaves is employed as a gargle. Reduced to a powder, they serve effectively as a healing ointment. They are also good made into a poultice, especially when placed over the kidneys to calm fevers. The fruit, being a quick, mild acid, and astringent, is often used as a refreshing drink in the sick room and is especially efficacious in fevers; toasted and ground or broken and put into hot water it is a sure remedy against the worst cases of diarrhea, dysentery, and cholera; being perfectly harmless the fruit or decoctions may be eaten or drunk in any quantity. The plant is widely distributed, from always dry, rainless Coquimbo to Chiloe's perpetual moisture."

Distribution.—Along ravines from central Chile to Puerto Veras.

26307 and 26308. Avena sativa L. **Oat.**

26309. Boquila trifoliata (DC.) Decaisne.

"'Voquil blanco,' 'boquila,' and 'pilpil blanco' are the Indian names. It grows along the edges of the woods from the thirty-fifth degree of latitude south to and including the island of Chiloe; it avoids altitudes and seeks the moist lowlands. The fruit is without importance."

26310 and 26311. Chusquea quila (Poir.) Kunth. **Bamboo.**

"This seed is from the provinces of Cautin and Malleco, in the vicinities of the volcanos Lonquimai, Llaimi, and Villa Rica. Several small lots from

26304 to 26329—Continued.

26310 and 26311—Continued.

different places are contained in this shipment and may or may not be all of the same variety. They are not of the Valdivia class."

Distribution.—The Chilean coast from Valparaiso to Chiloe.

26312. Citrullus vulgaris Schrad. **Watermelon.**

"A watermelon that was harvested in February and eaten in July."

26313. Cucumis melo L. **Muskmelon.**

"A melon that grew without water in the poorest arid soil."

26314 and 26315. Embothrium coccineum Forst.

26314. " 'Notru,' 'el ciruelillo.' A beautiful, flowering ornamental tree fit for any place. Has bunches of bright crimson flowers in early October and dark-green leaves, which are pale green beneath. It grows in the south up to 22 feet and 12 to 16 inches in diameter. A decoction of the bark or leaves is used to cure glandular affections; infusion or smoke cures dental neuralgia, and is also used to cicatrize wounds."

26315. "'Lirhuerillo.' From the Province of Llanquihue. Useful as a timber tree."

Distribution.—The southern part of Chile.

See Nos. 25491 and 25492 for previous introductions.

26316. Eucryphia cordifolia Cav.

"North of Valdivia this is called 'Ulmo;' at the south 'Muermo.' An evergreen tree with dense foliage, very beautiful on account of its abundant bunches of beautiful, white, fragrant flowers; it grows 50 feet high and 2 feet in diameter. Its hard wood is tan colored, of good quality for charcoal and bright blazing fuel, extra-durable railroad ties, heavy timbers, planks or boards, casks and vats, furniture, or any inside work; it becomes a darker red from exposure and age. Its wood and bark are highly impregnated with tannic acid. The bark contains about 35 per cent of tannin of great excellence, which quickly tans leather of superior quality and of much flexibility. The tanned product has a clean, light-buff color and an increased weight over the crude skins. The tannin of the wood serves for tanning, but is not used on account of its giving leather a blue cast. Ulmo bark is better than lingue and has been successfully applied in the form of concentrated extracts; its superiority as a tanning compound is of recent knowledge. It flowers in November and December and seeds in March and April."

Distribution.—The region around San Carlos, Chile, and extending south to the island of Chiloe.

See No. 25490 for previous introduction.

26317 and 26318. Gevuina avellana Molina.

26317. "'*Avellana.*' One of the handsomest trees in the world; its glossy, evergreen leaves, bunches of white, fragrant flowers and crimson nuts all at the same time, and its general symmetrical grace and beauty, make a very impressive sight. It grows in the Cordilleras of south and central Chile to the thirty-fourth degree of latitude and not beyond; is also found in the low coast range of the Cordillera Maritima. These seeds were found growing in latitude 44°; they need to be soaked in water a long time to germinate; they thrive in any soil, dry or wet, high or low lands here, but moist land is best for them. The wood of this tree is tough and elastic, takes a high polish, and is good for furniture."

26304 to 26329—Continued.

26317 and 26318—Continued.

26318. "'*Avellana.*' From the Cordillera of central Chile. Soak the seeds well."

See No. 25611 for previous introduction and distribution.

26319. GREIGIA SPHACELATA (R. and P.) Regel.

"'*Chupones.*' From the mainland in the Province of Llanquihue."

Distribution.—In humid situations about Concepcion, Chile, and south to the province of Llanquihue.

See No. 25476 for previous introduction.

26320. GUNNERA CHILENSIS Lam.

"'*Nalca.*' This grows only in wet places, banks of streams, ravines, etc. It is like a giant pieplant or rhubarb and is very ornamental; it is somewhat different from 'Pangue' (S. P. I. No. 25477); the former is eaten raw after the bark or skin is removed and has an agreeable sweet-acid taste; its juice made into ices is eaten with gusto. A decoction for diarrhea, etc., is made from the roots, which are hard and very astringent; the small quantity of juice which they contain is a valuable, permanent black dye for cloths and is estimable for tanning skins. The new sprouts are much esteemed by the Indians; they call them 'pampancallhue.' Oxen eat the leaves with relish when accustomed to them."

See No. 25477 for previous introduction and distribution.

26321. LAURELIA SEMPERVIRENS (R. & P.) Tul.

"Indian name 'el huahuan.' The evergreen laurel is too well known to need description. The industrial applications, large dimensions and merits of its timber, durability when not exposed to the elements, facility to work, ability to permanently receive any stain, etc., require no comment. It is necessary to cut the tree for lumber when the sap is down. It grows to immense size in the Cordilleran foothills of the south and gradually diminishes in size as it is found north of the river Bio Bio. It has nearly all the medicinal properties of *Laurelia aromatica*, among which are the following: An infusion of the scraped or pounded wood, the leaves or flowers is used to cure pains in the head which are the results of colds; the same and especially an infusion of the leaves is used for affections of the digestive tubes, urinary organs, to combat bronchitis and as baths or lotions to strengthen the nervous system, to alleviate or moderate paralysis, to fumigate the body against spasmodic convulsions; a pomade made of the powdered leaves cures skin diseases. The ground bark being placed in the cavity of a tooth stops the pain; an infusion of the bark is used as a remedy for lockjaw, etc."

Distribution.—Frequent in the woods in the vicinity of Valparaiso, Chile, and south to the island of Chiloe, rising to an elevation of 8,000 feet on the mountain slopes.

26322 and 26323. MAYTENUS BOARIA Molina.

26322. "Large-leaved variety." **26323.** "Small-leaved variety."

"An evergreen forest tree, native name 'el maiten.' A beautiful, fine-leaved, dense, semidrooping, small-limbed, shade tree of rare excellence, growing naturally in a round form up to a height of 12 meters and about 12 inches thick. It naturally seeks the dryest, poorest, arid lowland soils. It has great value as forage for horses and cattle; in times of drought or grass failure, hungry animals are kept alive by breaking a few branches daily and feeding the leaves. The wood is fine grained, hard, elastic, and mostly plain white and pale yellow, some-

26304 to 26329—Continued.

26322 and 26323—Continued.

times with a light pinkish-red cast; some varieties are beautifully veined with red and olive colors. The Araucana Indians use the wood to make their bows."

Distribution.—Dry lowlands along the Chilean coast and south to Patagonia.

See No. 23272 for previous introduction.

26324. NOTHOFAGUS sp.

"'*Rauli.*' A giant forest tree of the greatest industrial value; it may be favorably compared with the American black walnut in respect to its uses and commercial importance. Like the finest pines it is used to make all kinds of sash, doors, blinds, and for every class of furniture, and inside and outside construction; it is durable, easy to work, receives and long retains any paint or stain, admits of the highest class of polish, is tasteless, and is largely used for wine casks, tubs, vats, store fixtures, etc. The wood does not warp, split, fade, or rot. The trunks are long and extra thick, requiring the full capacity of both the upper and lower saws of the mills to cut them through. In my opinion 'rauli' is the most valuable wood in Chile for general uses. Grows only in the provinces of Nuble, Conception, Malleco, and Cautin."

26325. QUILLAJA SAPONARIA Molina.

"'*Quillai.*' It will certainly pay to plant plantations of this valuable tree. The natural source of supply is exhausted. They seek the dry hillsides and foothills, where they thrive in the driest and worst kinds of arid soils."

Distribution.—In the valleys and on the plains at the base of the mountains from Illapel, south to the valleys of the Angol and Levu rivers, Chile.

26326. RHAPHITHAMNUS PARVIFOLIUS Miers.

"In the province of Valdivia this is called 'espino blanco;' further south the Indians call it 'arrayan macho,' 'arrayan de espiño,' 'guayun,' and 'repu.' It is an evergreen bush or treelet about 20 feet high, good for live fences and ornament."

Distribution.—The southern part of Chile and the adjacent islands.

26327. SOLANUM sp. **Potato.**

26328. SOPHORA TETRAPTERA J. Mill.

"'*Pelu.*' This treelet of 12 to 15 feet is beautifully ornamental, having abundant bunches of fragrant, yellow flowers, which come in August and September before the leaves appear. The wood is not very thick, but is extra valuable on account of its extreme hardness; it is used for hubs, spokes, plow points, pulleys, cogwheel teeth, pins for sailing boats, ships, etc. It grows between Concepcion on the north and Puerto Montt south, also upon the island of Juan Fernandez, where it is called 'Guayacan.' The scraped wood serves as a stimulant and cathartic. It is also used for chronic rheumatism, gout, syphilis, and cutaneous diseases. Lasts forever in water."

See No. 25479 for previous introduction.

26329. TEPUALIA STIPULARIS Griseb.

"'*Tepu.*' This is a small, beautiful tree, which grows along the coast of Chile from Valdivia to the island of Chiloe, where it forms dense impassable forests; the Indians call these woods 'Tepuales.'

26330 to 26343. THEA SINENSIS L. **Tea.**

From China. Procured by Vice-Consul Nightingale under directions from Mr. S. L. Gracey, American consul at Foochow, at the suggestion of Ambassador

26330 to 26343—Continued.

Rockhill before he left Pekin for St. Petersburg, Russia. Plants received at the Plant Introduction Garden, Chico, Cal., December 1, 1909; seeds received at Washington, D. C., December 6, 1909.

Plants of the following:

26330 to 26332. From the Kienning district.

26330. *Lotus Heart.*

26331. *Water Fairy.*

26332. *Dragon Pool.*

26333 to 26336. From Wuishan district, the cliff-grown teas from River of the Nine Windings.

26333. *White Cock Comb.*

26334. *Great Red Robe.*

26335. *Superior.*

26336. *Dragon Pool.*

Seeds of the following:

26337. *Water Fairy* (parent plant).

26338. *Dragon Pool* (parent plant).

26339. *Dragon Pool.* From Heaven Sauntering Place.

26340. *White Cock Comb* (parent plant).

26341. *Red Robe* (parent plant).

26342. *Red Robe.* From Heaven Heart Temple.

26343. *White Peony* (parent plant).

"The cliff-grown teas are extremely rare and valuable, and I do not believe can be obtained again, as the Chinese are not at all anxious to have the tea of this district become general. The department having for some years past written for seed of the 'Dragon Pool teas,' which I was unable to obtain otherwise, though repeated requests have been made, I sent my vice-consul, Mr. Nightingale, and through the extreme courtesy of the viceroy of Fukien, the magistrate of Chungan, and two mandarin friends, he was allowed to gather seeds and select the plants I send. There is 200 miles of foot journey besides considerable boat trip from Foochow to this district, which involves some expense. The peculiar flavor of these cliff-grown teas is said to come from the soil, and other soil may impart an entirely different flavor to the same plant. The earth about the cliff teas is very sandy and not at all rich. A rich soil they claim is not good for tea, as the plant will grow too high and not remain stunted, as is considered desirable. In this district frost occurs often, and now and then there is light fall of snow, which lasts but a short time. The entire district of the River of the Nine Windings is composed of huge red sandstone cliffs and bowlders, and in the shadow and clefts of these, wherever a little of the sandy soil is found, the tea grows. Other than a little digging about the roots at this season of the year (October), no attention is necessary.

"Some fertilize the plants once or twice a year with night soil; the fertilization is not considered necessary.

"Some plants produce as many as four kinds of tea, according to the size of the leaf and the time of gathering. The teas of this district in order of superiority are 'White Cock Comb,' 'Great Red Robe,' 'Superior,' 'Lotus Heart,' 'Water Fairy,' and 'Dragon Pool.' The White Cock Comb and the Red Robe plants were those growing closest to the original plant. The White Cock Comb is said to be 'the original tea plant and to have fallen from heaven;' twice a year the Chungan magistrate comes to see that it is all right and worship at a neighboring temple. The Dragon Pool tea plants are from a little inclosure back of this temple, where a brother of an emperor in the Sung dynasty retired at one time to raise tea, and which I believe has given rise to the story of the

26330 to 26343—Continued.

'Royal Inclosures.' The 'Special Tea' comes from the Chungan magistrate's private stock. The Kienningfu plants produce an inferior quality of tea from that of the cliff district. These plants may be raised from cuttings in the spring; those of the cliff district by seed only.

"The seeds should be soaked in water twenty-four hours before planting, and then planted in the open to a depth of 5 inches in low mounds 3 feet apart; ridges should be made so the rain runs freely from the mounds. Considerable moisture after planting is not desirable.

"The Dragon Pool seed sent is from the Wuishan district. All the seeds are authentic, as Mr. Nightingale gathered them personally." (*Extract from letter dated October 25, 1909, written by Consul Gracey to Mr. George S. Baker, United States dispatch agent, San Francisco, Cal.*)

26344 to 26352. ROSA spp. **Rose.**

From Woods Hole, Mass. Presented by Mr. M. H. Walsh. Received December 2, 1909.

Plants of the following Rambler roses; descriptive notes by Mr. Walsh:

26344. "*Kalmia* is a beautiful light Kalmia formed and colored flower, single."

26345. "*Bonnie Belle* is carmine and pink, single."

26346. "*Delight*, bright red."

26347. "*La Fiamma*, single; intense crimson, with white center."

26348. "*Coquina*, as its name denotes, is shell color."

26349. "*Milky Way*, single, white, large flower; an improved wichuriana."

26350. "*Lady Blanche*, double white wichuriana hybrid; very dark, glossy foliage; flowers borne in clusters similar to Lady Gay. This variety is deliciously fragrant."

26351. "*Excelsa* is double, crimson maroon, with tips of petals fiery scarlet; this will rank as one of the best."

26352. "*Jessica*, a climbing variety, large glossy foliage; large, double flower, cotton white, fragrant; a valuable acquisition."

26353. METTERNICHIA WERCKLEI K. Schum.

From San Jose, Costa Rica. Presented by Mr. Ad. Tonduz. Received December 4, 1909.

"Fleshy roots of what Mr. Carlos Wercklé calls the 'edible tuber' of *Metternichia wercklei* K. Schum. (Solanaceae); he experimented with eating these pseudotubercles and found them agreeable and without any poisonous principle. *Metternichia wercklei* grows in the high plateaus of La Palma, near San Jose, at 5,000 feet altitude. It is sometimes a branching bush, 7 to 10 feet high, which grows in the ground, and sometimes a semiepiphyte which grows in rotted trunks of trees or in a hollow of some large tree. Mr. Wercklé says that this bush can be propagated very easily by means of pieces of roots." (*Tonduz.*)

26354. CRATAEGUS AZAROLUS L.

From Acre, Palestine. Presented by Miss Rifka Aaronsohn, Zichron-Jacob, near Haifa, Palestine. Received October 19, 1909.

"Seed of the large, red-fruited variety." (*Aaronsohn.*)

See No. 26116 for description.

26355. Populus lasiocarpa Oliver.

From Chelsea, London, England. Purchased from Messrs. James Veitch & Sons. Received December 8, 1909.

"The ovate cordate leaves of this new poplar are extremely large and attractive, measuring 10 to 12 inches in width. They are bright green in color, whilst the petiole, midrib, and principal veins are of a rich red hue. The tree in central China attains a height of 15 to 40 feet and should prove a valuable addition to our ornamental deciduous trees." (*Veitch & Sons.*)

Distribution.—Central China, in the provinces of Hupeh and Szechwan.

26356 to 26362.

From Malkapur, Berar, India. Presented by Mr. A. S. Dhavale. Received November 29, 1909.

Seeds of the following; quoted native names as given by Mr. Dhavale:

26356. Crotalaria juncea L.

"*Boru.*"

Distribution.—Plains of India from the Himalayas to Ceylon, the Malayan Islands, and Australia. Cultivated for fiber.

26357. Dolichos biflorus L.

"*Kulitha.*"

26358. Dolichos lablab L. **Bonavist bean.**

"*Val.*"

26359. Guizotia abyssinica (L.) H. Cass.

"*Karala.*"

26360. Phaseolus max L.

"*Urid.*"

26361. Phaseolus radiatus L.

"*Mug.*"

26362. Vigna catjang (Burm.) Walp.

"*Chavali.*" Brown eye, small.

26363 to 26385. Garcinia mangostana L. **Mangosteen.**

Grown at the United States Department of Agriculture greenhouse, Washington, D. C., numbered December 17, 1909.

"These seedlings were raised from S. P. I. No. 21276, received through Mr. H. F. Macmillan, Royal Botanic Gardens, Peradeniya, Ceylon, August 22, 1907. The seedlings were inarched to 4-year-old plants of *Garcinia tinctoria* (DC.) W. F. Wight (*G. xanthochymus*), S. P. I. No. 11788, raised from seeds obtained from Dr. John C. Willis, director of the Royal Botanic Gardens, Peradeniya, Ceylon, October 31, 1904. *G. tinctoria* was used as a nurse plant to which the seedlings of the mangosteen were inarched. Since the unions were effected the mangosteens have made splendid growth and this method promises to be the best one so far as my experimental work in the propagation of the mangosteen has gone. It has been deemed best to give each of these inarched plants a separate S. P. I. number, so that they will not be confused with other mangosteens worked by different methods." (*G. W. Oliver.*)

26386. Punica granatum L. **Pomegranate.**

From Tripoli, in Barbary, North Africa. Forwarded by the American vice-consul, at the request of Mr. William Coffin, American consul, who presented them to the Department. Received December 10, 1909.

26387 and 26388.

From Georgetown, Demarara, British Guiana. Presented by Mr. F. A. Stockdale, assistant director and government botanist, Science and Agriculture Department, Botanic Gardens. Received December 10 and 11, 1909.

Seeds of the following palms:

26387. Attalea cohune Mart.

See No. 1970 for description.

Distribution.—Honduras, and the northeastern part of South America.

26388. Copernicia tectorum (H. B. K.) Mart. (?)

Distribution.—The valley of the Orinoco River, in South America.

26389 to 26397. Zea mays L. **Corn.**

From Hamburg, Germany. Purchased from Mr. Albert Schenkel, 47 Rosenstrasse. Received December 10, 1909.

Seeds of each of the following; names of varieties as catalogued:

26389. Zea atropurpurea.

26390. Zea caragua.

26391. Zea gracillima variegata.

26392. Zea gracillima variegata *gigantea*.

26393. Zea gracillima zebrina aurea.

26394. Zea japonica, foliage variegated.

26395. Zea japonica gigantea quadricolor.

26396. Zea sp. Rissen mais von Peru.

26397. Zea tunicata, foliage variegated.

The above were purchased for the experiments of Mr. G. N. Collins, assistant botanist, Bionomic Investigations, this Department.

26398. Citrus aurantium sinensis L. **Orange.**

From Toliman Barranca, Hidalgo, Mexico. Presented by Mr. Jorge J. White, Zimapan, Mexico. Received December 15, 1909.

"Cuttings of an orange that retails for 10 centavos each in Mexico City; it is small and extremely sweet, and I believe with care will make a fancy shipping orange. The barranca where they grow was settled by the Spanish padres, who, I believe, introduced the orange; owing to neglect by the Indians, who own all the trees, which are now very few, I suppose that the fruit has deteriorated, but careful cultivation and perhaps crossing might give a remarkably fine orange.

"The winters here are very mild; the soil, generally speaking, is very poor and full of gravel, and is also thin, not exceeding a meter in thickness; underlying the soil is the usual detritus—coarse bowlders—found in the beds of mountain streams. The elevation is about 4,000 feet above sea level." (*White.*)

26399 to 26406. Vigna unguiculata (L.) Walp. **Cowpea.**

From Mount Selinda, Rhodesia, South Africa.

Presented by Mr. C. C. Fuller, through Mr. W. L. Thompson, M. D. Received November 27, 1909.

Seeds of the following, with descriptions of same:

26399. Small, black.

26400. Large, black.

26401. Small, speckled.

26402. Large, speckled.

26403. Maroon.

26404. Small, buff.

26405. Large, buff.

26406. Cloudy violet and buff.

26408. Gossypium hirsutum L. Cotton.

From Northern Arabia. Presented by Dr. Arthur K. Bennett, Arabian Mission, Busrah, Persian Gulf, via Bombay. Received November 20, 1909.

"Seed of a cotton which I found while traveling across northern Arabia. The women were weaving a light-brown cloth from this kind of cotton, and they say it is bigger and better than the white." (*Bennett.*)

26411. Ipomoea sinuata Ortega.

From Iguala, Mexico. Collected by Dr. David Griffiths. Received December 23, 1909.

"Seeds of a native ipomœaceous vine which climbs over shrubs in the valley of Iguala, Mexico. The vine itself is a handsome thing. I have not seen the flowers." (*Griffiths.*)

26412. Caryophyllus malaccensis (L.) Stokes. Large rose-apple.

From Honolulu, Hawaii. Presented by Mr. J. E. Higgins, horticulturist, Hawaii Experiment Station. Received December 16, 1909.

"The mountain-apple, as it is locally known in Hawaii, is a very beautiful fruit of a very dark red color when at its best. It is about the size of a small pear and is of mild, rather pleasing flavor. The tree grows to a height of 40 or 50 feet in the wild condition in the mountains and moist gulches, and bears fruit freely. The usual season is from June to September. It is probable that some interesting results would be obtained by the crossing of this species with some of the more highly flavored species of Eugenia, such as *E. michelii* (=*E. uniflora*)." (*Higgins.*)

Distribution.—Throughout the Polynesian islands; varieties in cultivation in Bengal and Burma.

26413. Psidium laurifolium Berg.

From Port of Spain, Trinidad. Presented by Mr. F. Evans, acting superintendent, Botanical Department, Department of Agriculture. Received December 10, 1909.

"Jelly made from this fruit has been found to be of considerable value, from the fact that by its agreeable acidity it is quite distinct in flavor from the ordinary guava jelly made from *Psidium guajava* and *P. polycarpum*. It is also said that it 'jellies' much quicker than the common West India guava.

"It is a plant, therefore, which is likely to become widely distributed on account of its usefulness. The jelly, with soda and ice, makes an excellent 'soft' or 'cool' drink equal to or better than any of the ordinary fruit sirups." (*Extract from Bulletin 57, Trinidad Botanical Department, January, 1908.*)

Distribution.—The vicinity of Masaya, near the Pacific coast of Nicaragua.

26414 to 26418. Citrullus vulgaris Schrad. Watermelon.

From Salisbury, Md. Grown by Mr. W. F. Allen; presented through Prof. W. W. Tracy. Received December 15, 1909.

Seeds of the following selections made from the Roumanian watermelons received through Consul Knowles; notes by Mr. Allen:

26414. Rind nearly white; yellow flesh; reddish-brown seeds.

26415. Striped rind; red meat; reddish-brown seeds.

26416. Rind nearly white; red flesh; reddish-brown seeds.

26414 to 26418—Continued.

26417. Striped rind; red flesh; black seeds.

26418. Rind nearly white; red flesh; small reddish-brown seeds. This variety was quite uniform, there being only one type; grown from the second lot of S. P. I. No. 22658, received May 14.

26421 to 26423.

From Hwai Yuan, via Nanking, China. Presented by Mr. Samuel Cochran, American Presbyterian Mission. Received October 15, 1909.

Seeds of the following; notes and native names by Mr. Cochran:

26421. Citrullus vulgaris Schrad. **Watermelon.**

"Hwang jang hsi kwa," yellow fleshed.

26422 and 26423. Brassica pekinensis (Lour.) Skeels. **Pe tsai cabbage.**

26422. *T'ang pei ts'ai* (soup white vegetable).

Planted in spring, summer, and autumn by sowing thickly on freshly cultivated soil and then raking in. Ready for use in 20 to 30 days. Eaten boiled. It is also sometimes transplanted from the beds sown as above into rows, each bunch being a foot or so apart. It then grows into large, thick-stalked bunches which are pickled and eaten during the entire year. It is gathered at first hoarfrost when grown in this way, as the first frost kills it.

26423. *P'iao pei ts'ai* (dipper white vegetable).

So called from the shape of the leaf. Sown in beds in August and transplanted into rows in bunches, each clump being separate. It is transplanted in September or early October, and is ripe when snow falls; it continues to ripen through the winter in spite of frost and snow, but its quality is improved by being covered with straw.

26424 to 26439.

Procured by Mr. A. J. Perkins, of the firm of Jackson & Perkins, Newark, N. J., while making a trip through Japan. Received December 8, 1909.

Seeds of the following obtained in Japan, unless otherwise noted; descriptive notes by Mr. Perkins:

26424. Akebia lobata Decaisne.

A vine from which baskets are made at Aomori, Japan. It is used as an ornamental in the United States. Seeds of an especially large-fruited variety as well as a common kind are contained in this lot.

See No. 24744 for previous introduction and distribution.

26425. Citrus sp. **Orange.**

"*Yusu.*" A Japanese sour orange, round and flat. Used as lemon and as a stock.

26426. Citrus trifoliata L.

Seed from a tree in the Yokohama Nursery Co.'s grounds.

26427 and 26428. Cucurbita pepo L. **Squash.**

26427. "*Chirimen.*" Has a rough, knotted exterior; named after a kind of silk having rough knots in its texture.

26428. "*Kikuza.*" Has a smooth exterior, as its name signifies.

Both these kinds are said to have yellow meat 1½ inches thick which is of fine flavor when boiled.

26424 to 26439—Continued.

26429. Diospyros kaki L. f. **Persimmon.**

These seeds are from nonastringent fruit.

26430. Euonymus oxyphyllus Miq.

From Botanical Gardens, Sapporo, Japan.

Distribution.—The vicinity of Port Chushan, Korea; also Japan.

26431. Fedia scabiosaefolia (Fisch.) Trev.

"*Omineshi.*" An ornamental herbaceous perennial from Morioka, Japan.

Distribution.—The provinces of Chihli, Shingking, Kiangsu, Chekiang, Fukien, Hupeh, and Kwangtung, in China; Korea, and Japan.

26432. Firmiana simplex (L.) W. F. Wight

"*Ao giri.*" From Morioka, Japan.

26433. Hordeum distichon nudum L. **Naked barley.**

"*Shiratama*" (white grain). Winter barley, procured by Prof. Gentau Tamada, from Morioka, Japan.

26434. Hordeum vulgare coeleste L. **Barley.**

"*Marumi*" (round seed). From Messrs. Aizawa & Co., Sapporo, Japan.

26435 and 26436. Perilla nankinensis (Lour.) Decais.

26435. White or green leaved variety.

26436. Purple-leaved variety.

Known in Japan as "Shiso;" edible, being used as a condiment in cooking and to color pickles in combination with *Prunus mume.*

Distribution.—The provinces of Kiangsi and Szechwan, China; also Japan.

26437. Pithecolobium dulce (Roxb.) Benth.

From Kapiolani Park, Honolulu, Hawaii. See No. 23457 for description.

26438. Sesamum orientale L. **Sesame.**

Black seeded.

26439. Zanthoxylum piperitum (L.) DC.

"*San-sho.*" A condiment, purchased in Hakodate.

Distribution.—Provinces of Shensi and Shantung, eastern China; the island of Port Hamilton, in the Korean Archipelago; and the woods on the mountain slopes in central Japan.

26440. ANONA LONGIFLORA S. Watson.

From Altadena, Cal. Presented by Mr. F. O. Popenoe. Received December 20, 1909.

Budwood taken from the tree which produced the seed sent in under S. P. I. No. 26298, which see for description.

26441. ANONA sp.

From San Salvador, Salvador, Central America. Presented by Mr. H. F. Schultz, Ancon, Canal Zone, Panama. Received November 23, 1908.

"I obtained the seed of this Anona from a friend of mine whom I met in Panama and who mailed it to me from San Salvador, Salvador. When I saw him at Ancon he spoke very highly of these 'sugar apples' of his country; beyond his verbal descriptions, which were very general, I have no guide regarding the identity of the species." (*Schultz.*)

26442 to 26456.

The following seeds were turned over to this office by Dr. R. H. True, physiologist in charge of Drug-Plant, Poisonous-Plant, Physiological, and Fermentation Investigations, for distribution, December 27, 1909.

26442.	Atropa belladonna L.	**Belladonna.**
26443.	Calendula officinalis L.	**Pot marigold.**
26444.	Cannabis sativa L.	**Hemp.**
26445.	Carum carvi L.	**Caraway.**
26446.	Nepeta cataria L.	**Catnip.**
26447.	Conium maculatum L.	**Conium.**
26448.	Coriandrum sativum L.	**Coriander.**
26449.	Digitalis purpurea L.	**Foxglove.**
26450.	Foeniculum vulgare Hill.	**Fennel.**
26451.	Inula helenium L.	**Elecampane.**
26452.	Lobelia inflata L.	**Indian tobacco.**
26453.	Althaea officinalis L.	**Marshmallow.**
26454.	Monarda fistulosa L.	**Horsemint.**
26455.	Spigelia marilandica L.	**Maryland pinkroot.**
26456.	Sesamum orientale L.	**Sesame.**

White seeded.

26457 to 26459. Hordeum spp. **Hull-less barley.**

From Nara, Japan. Procured by Mr. A. J. Perkins, from Dr. G. Nakamura, director, Experiment Station. Received December 22, 1909.

Seeds of the following; descriptive notes by Mr. Perkins:

26457. "*Zun-paku-mugi.*" Pure white naked barley; produces 1.751 koko per tau (one-fourth acre) and is hardy.

26458. "*Yane-hadake.*" This is hardy and produces more than 1 koko per tau.

26459. "*Kama-ore.*" Produces 2.005 koko per tau and is useful for both grain and straw.

26460. Citrus trifoliata L.

From Tokyo, Japan. Presented by Prof. Y. Kozai, director, Imperial Agricultural Experiment Station. Received December 27, 1909.

Large seeded. To be used for stocks.

26462 to 26465. Trifolium subrotundum Steud. & Hochst.

From Adis Ababa, Abyssinia. Presented by Mr. Hoffman Philip, American minister. Received December 20, 1909.

Seeds from plants found in a shady garden; descriptive notes by Mr. Philip:

26462. Most profuse variety; full flower; large leaves light in center; grows to height of about 1½ feet.

26463. Full flower; small leaves; grows to height of about 1 foot; not very profuse.

26464. Grows to height of about 3 feet; not very erect; large leaves, all one color.

26465. Grows to height of about 2 feet; not very erect; very narrow leaf."

26470. SPONDIAS DULCIS Forst. **We fruit.**

From Monrovia, Liberia. Presented by Mr. E. L. Parker, commissioner of agriculture. Received December 30, 1909.

"The we fruit (pronounced vee) or Tahiti-apple. The tree is of rapid growth, highly ornamental, and attains a height of 50 feet in its native habitat. The golden-yellow fruits, about 2 to 3 inches in diameter, are produced in loose clusters. The brownish-yellow flesh partakes of the flavor of a pineapple and most people become very fond of the fruit when once accustomed to it.

"The we fruit is indigenous to the Society Islands and is now disseminated to most tropical countries. In Florida, where it has fruited in Miami and Lemon City for at least four years, it appears well adapted to well-drained land underlaid with coral limestone. It is a trifle less hardy than the mango, to which plant the we fruit is related." (*P. J. Wester.*)

Distribution.—Cultivated throughout the Tropics; probably native in the Polynesian islands.

PUBLICATION OF A NEW NAME.

26078. CAPRIOLA INCOMPLETA (Nees) Skeels.

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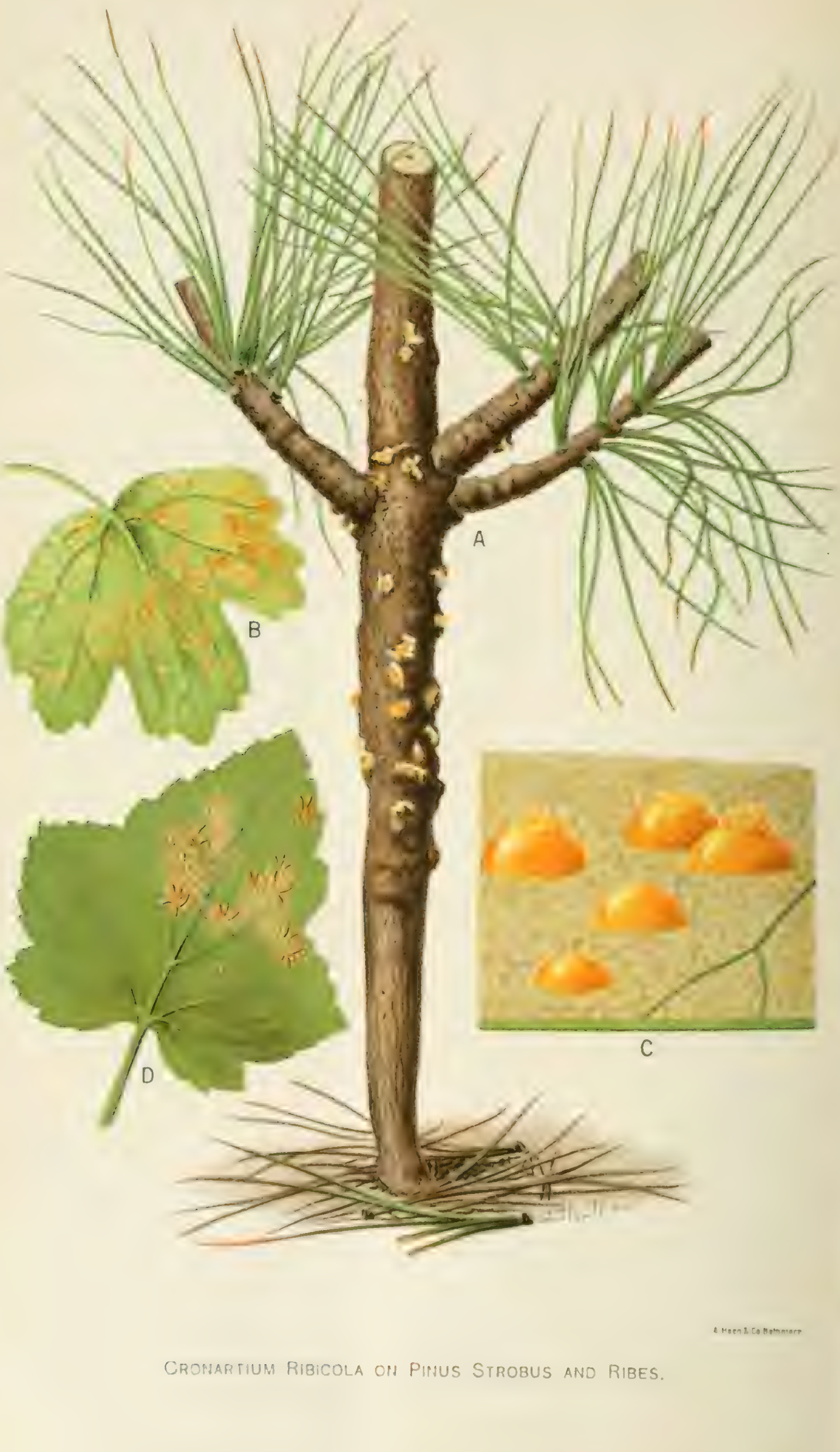

A. Hoen & Co. Baltimore

CRONARTIUM RIBICOLA ON PINUS STROBUS AND RIBES.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 206.
B. T. GALLOWAY, *Chief of Bureau.*

THE BLISTER RUST OF WHITE PINE.

BY

PERLEY SPAULDING,
Pathologist, Investigations in Forest Pathology.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., December 21, 1910.

Sir: I have the honor to transmit herewith a paper entitled "The Blister Rust of White Pine," by Dr. Perley Spaulding, Pathologist in the Office of Investigations in Forest Pathology, and recommend that it be published as Bulletin No. 206 of the special series of this Bureau.

This bulletin gives an account of a dangerous European disease of white pine, which also affects other five-needle pines and occurs on wild and cultivated currants and gooseberries. This disease has recently been widely introduced into America, but fortunately, by the prompt and active cooperation of all parties concerned, all cases found have been eradicated. But we have no evidence that all cases have been found, nor have we any means of preventing the importation of more diseased white-pine nursery stock. If this disease is not to become established in America, prompt action on all sides is necessary. It is therefore hoped that the recommendations of this bulletin will be generally carried out and that legislation may be enacted restricting further importations of diseased material.

The writer of this bulletin is indebted to the following persons for their cordial cooperation and aid in carrying on these investigations: The horticultural inspectors of New York, Pennsylvania, Ohio, and Indiana; the commissioners of agriculture and of forest, fish, and game in the State of New York; the State foresters of New York, New Jersey, Vermont, New Hampshire, Massachusetts, and Connecticut; the plant pathologists of Vermont, New York, Connecticut, Ohio, and Minnesota; the director of the Missouri Botanical Garden; Mr. George A. Chedel, and Drs. J. C. Arthur, W. G. Farlow, and Roland Thaxter.

Respectfully,

G. H. Powell,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE BLISTER RUST OF WHITE PINE.

INTRODUCTION.

Within the past quarter century the science of forestry has become fairly well known throughout the country and is being practiced to a very encouraging extent. The advance in our knowledge and practice of forestry has resulted in the development of a general reforestation movement, especially in the North Central and Northeastern States. To be sure, replanting has been done in a small way for fifty years or longer (Kempton, 1903 [a]), but it is only within the past decade that interest in the work has become very general. During the last three years New York, Vermont, and Connecticut have aided the movement by furnishing stock to planters at cost prices. Reforesting in the States mentioned is concerned very largely with coniferous species and especially with white pine (*Pinus strobus* L.), which was formerly the most important forest tree of this section.

Naturally the increase in the demand for suitable small coniferous trees has led to the establishment of a number of forest-tree nurseries which supply this commercial demand. Of course there have been for years nurseries which supplied relatively small quantities of this stock; these met the demand for stock for ornamental purposes but not for practical field planting. During the past year or two American nurserymen have been unable wholly to supply the suddenly increased demand for planting stock, the entire available supply being sold in spite of the action of the Northeastern States in furnishing planting stock at cost prices.

American prices have been and still are considerably higher than European prices for the same grade of stock. This is partly due to the higher cost of manual labor in this country and partly to the inefficient methods and supervision given to this crop by many American nurserymen. There are many Americans who are fully competent to raise young fruit-tree stock and who are very successful in this branch of nursery work. But this class of stock is not usually seriously affected with the damping-off diseases, while the coniferous seedlings are as a class especially susceptible to them.

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[a] For detailed information as to the works referred to in parentheses in this paper, see under "Bibliography," pages 61-78.

Certain species are nearly immune, but the larger number are seriously affected and many are very susceptible. Much of the damping-off in coniferous seedlings is caused by various species of Fusarium, fungi which are omnipresent in decaying organic matter both in the soil and on its surface. These diseases are dependent upon suitable weather conditions for their appearance in serious outbreaks in the seed beds, and they are very difficult to control when once they make their appearance. The average American nurseryman is unable to give his undivided attention to his seed beds, which is exactly what they need at times if he is raising conifers. Often prompt action on his part will avert or largely prevent a serious outbreak of damping-off. Lack of experience is often the cause of very large losses, and the cost of the remaining seedlings is unduly increased because of these excessive losses.

In a number of foreign countries, notably Germany, France, and Holland, the practice of forestry for centuries has resulted in a steady demand for great numbers of forest-tree seedlings for reforestation purposes. This has led to the establishment of many nurseries which supply planting stock at very reasonable prices. In Europe, where reforestation is largely carried on by national, State, or municipal authorities, the foresters employed often raise their own seedlings in the locality where they are to be used, and in some cases they even distribute surplus stock to private individuals free (Fox, 1903) or at cost. It is apparently not uncommon, however, for the seedlings to be bought of commercial nurseries (Fox, 1903; Thaler, 1903). The output of these nurseries mounts well up in the hundreds of millions. This stock is usually fine and thrifty and sells at a relatively low price as compared with similar American stock.

As a result of these various conditions, a considerable import trade in forest-tree seedlings and transplants has developed. There are many American nurserymen who regularly import their 1-year-old coniferous seedlings rather than raise them themselves. It is no exaggeration to say that in the spring of 1909 probably ten million coniferous seedlings were imported into this country from various European nurseries. Of these, several millions were white pine (*Pinus strobus*), 1-year-old and 2-year-old seedlings and 3-year-old transplants. A considerable number were also imported of each of the following five-leaved species, which are very closely related to *Pinus strobus*:[a] *Pinus monticola* Douglas, *P. lambertiana* Douglas, *P. flexilis* James, *P. cembra* L., *P. excelsa* Wall., *P. peuce* Gris., *P. ayacahuite* Ehrenb., *P. koraiensis* Sieb. and Zucc., *P. parviflora* Sieb. and Zucc. These were usually imported by nurserymen who make a specialty of landscape gardening, and these species were used entirely for ornamental planting, thus being much more widely distributed than would be the case if they were used for forest planting.

---

[a] Beissner, L. Handbuch der Nadelholzkunde, 1909, pp. 340-371. The second edition is used in naming the 5-leaved pines.

The importation of foreign plant material, whether of seeds, cuttings, or whole plants, is accompanied with constant danger of introducing insect or fungous pests. The danger of introducing fungous pests is rather slight with seeds, although the contrary is true of insects, but with plants or cuttings the danger of introducing both fungi and insects is considerable unless suitable precautionary measures are taken. Insects, with certain exceptions, such as the woodborers, may be killed by fumigation, while most fungous diseases can be detected by a rigid examination by a competent mycologist. There are fungous diseases, however, which at certain stages can not be detected even by the most skilled mycologist, owing to their having a preliminary stage of incubation during which the disease is not externally visible. The smuts of grain and other plants are very good examples of this kind of diseases. These fungi infect the young seedling host when it emerges from the seed, and the mycelial threads grow in the tissues of the stem until the formation of seeds is begun. All of this time (two or more months) the fungus gives absolutely no external indication of its presence. When the seed begins to form, the fungus commences to form its fruits within the seed and then becomes visible externally for the first time. The white-pine blister rust caused by *Cronartium ribicola* is one of this type of diseases, but has an incubation period of one to four years instead of a few months, as in the case of the smuts.

White-pine seedlings and transplants have been imported in relatively small numbers for years, and it is rather remarkable that the blister rust of white pine was not imported in quantity before 1909, when the Peridermium stage was first discovered in America. Mycologists and plant pathologists have been on the lookout for it for some time, and it could hardly have been previously imported to any extent without discovery. A few American foresters have refused to accept foreign white-pine seedlings and transplants because of their fear of this disease. These men were familiar with European conditions and thoroughly appreciated the danger of importing the fungus.

The white-pine blister rust now imported into this country from Germany is caused by a heteroecious fungus requiring two distinct kinds of hosts for its complete development. It lives in the one stage in the bark of white pines (Pl. I, *A;* Pl. II, figs. 1 and 2; text figs. 3, 4, and 5) and in the other stage in the leaves of wild and cultivated currants and gooseberries, known by the scientific name Ribes (Pl. I, *B*, *C*, *D*). The first stage fruits in the spring and summer, from early April to early June, while the latter stage fruits from about June 1 until the leaves of the Ribes fall.

HISTORICAL ACCOUNT OF CRONARTIUM RIBICOLA.

H. A. Dietrich, in 1856, in an annotated list of the fungi of the Baltic provinces of Russia, mentions *Cronartium ribicola*. About one or two years previously Dietrich apparently distributed in a set of dried plants entitled "Plantarum Florae Balticae Cryptogamarum" specimens of this fungus under the same name. This seems to have been the first time the name *Cronartium ribicola* was used. The writer has been unable to refer to the original specimens because he can not find anywhere in the country a set of these exsiccatæ. Nearly all European writers have attributed the name to Dietrich. This name was at first used only in connection with the fungus upon the leaves of Ribes, which was considered to be a distinct species. In 1887 Klebahn separated the species *Peridermium pini* (Willd.) Kleb., forma *corticola*, into three distinct species—*Peridermium pini*, *P. cornui* Rostr. and Kleb., and *P. strobi* Kleb. The third had *Pinus strobus* for its host, while the two others had other species of pine for their hosts. The Peridermium had previously been known on white pine in Europe, but had been included in the old composite species *P. pini*. In 1888 Klebahn proved that *Peridermium strobi* is but a stage in the life history of *Cronartium ribicola* by successfully inoculating Ribes leaves with spores of the former from white pine and obtaining upon the leaves of Ribes the characteristic spores of the latter.

These experiments were later repeated by Klebahn, as well as by a number of other investigators, viz. Von Wettstein (1890), Rostrup (1895), Schøyen (1895), Eriksson (1896 *a*), Von Tubeuf (1901 *a*), Hennings (1902 *a*), Sorauer (1891), and Jaczewski (1905, 1906, 1908). The following table shows the various species of Ribes upon which successful inoculations have been made with æcidiospores from *Pinus strobus*, including the writer's own experiments here cited for the first time.

Successful inoculations on Ribes with spores of Peridermium strobi from Pinus strobus.

Ribes.

1. Subgenus Siphocalyx:
    - *aureum* Pursh.—Klebahn (1890 *b*, 1892 *a*), Sorauer (vide Klebahn, 1904 *a*), Von Tubeuf (1901 *a*), Spaulding.
2. Subgenus Ribesia:
    - *nigrum* L.—Hennings (1902 *a*), Klebahn (1888 *b*, 1890 *b*, 1892 *a*, 1897 *b*), Eriksson (1896 *a*), Jaczewski (1905, 1906, 1908), Schøyen (1895), Sorauer (1891), Von Tubeuf (1901 *a*).
    - *sanguineum* Pursh.—Sorauer (vide Klebahn 1904), Von Tubeuf (1901 *a*).
    - *americanum* Mill.—Sorauer (vide Klebahn (1904), Spaulding.
    - *alpinum* L.—Klebahn (1890 *b*, 1892 *a*), Sorauer (1891).
    - *rubrum* L.—Klebahn (1890 *b*, 1892 *a*), Sorauer (1891), Schøyen (1895), Von Tubeuf (1901 *a*), Spaulding.
    - *multiflorum* Kit.—Rostrup (1895).

Ribes—Continued.

3. Subgenus Grossularia:
    - *Cynosbati* L.—Von Tubeuf (1901 *a*), Spaulding.
    - *setosum* Lindley.—Sorauer (vide Klebahn, 1904).
    - *oxyacanthoides* L.—Von Tubeuf (1901 *a*).
    - *gracile* Michx.—Rostrup (1895).
    - *divaricatum* Douglas.—Von Tubeuf (1901), Rostrup (1895).
    - *rotundifolium* Michx.—Sorauer (vide Klebahn, 1904).
    - *grossularia* L.—Klebahn (1895 *a*), Schøyen (1895), Von Tubeuf (1901), Spaulding.

Tranzschel (vide Magnus, 1902) inoculated *Ribes nigrum* successfully with æcidiospores from *Pinus cembra* in 1894, thus showing that the fungus on this pine is identical with that on *Pinus strobus*. Neger (1908) found that *Ribes sanguineum* which he had previously set out near trees of *Pinus monticola* that were diseased with Peridermium became abundantly rusted with *Cronartium ribicola*. This proved the identity of the Peridermium upon the three species of pine, all being forms of *Cronartium ribicola* (fig. 2). Klebahn (1887) cites the occurrence of what is apparently the same species of Peridermium upon a single tree of *Pinus lambertiana* and later (1890 *b*) he was successful in inoculating Ribes with spores from this species. The Peridermium upon all four species of pine has the same morphological characters, and there is little doubt that they are identical. Rostrup (1902) states that he found *Pinus excelsa* diseased with Peridermium, but he does not state that it is *P. strobi*. The infection of pine with pycnospores from pine has been attempted by Klebahn (1889, 1904 *a*). He inoculated young *Pinus strobus* with pycnospores from the same species and obtained one or two apparent infections, but finally concluded that his experimental trees were already infected before he began his experiment. He later (1899) repeated the experiment with no results. Klebahn (1904 *a*) also tried inoculating *Pinus strobus* with æcidiospores from the same host, but without result. Tests made with teleutospores by Klebahn (1905 *a*) upon young *Pinus strobus* trees were successful, however. Ten months after the inoculations were made, the twigs showed swellings and had their needles of the juvenile form; later the usual form of needle was produced. The twig growth was short and the old needles were spotted and yellowish in color. Spermogonia were produced within one year from the time of the inoculation. Various tests have also been made by Klebahn (1908, 1897 *b*) with the spores of *Peridermium pini* upon Ribes and with spores of *P. strobi* upon the alternate hosts of *P. pini* with no results, thus proving them to be distinct.

DISTRIBUTION OF CRONARTIUM RIBICOLA.

CRONARTIUM RIBICOLA IN THE OLD WORLD.

Cronartium ribicola in one or both of its forms has been collected in and reported from the countries of the Old World as follows:

NORWAY. Schøyen (1895, 1896, 1897, 1901, 1903), Blytt (1896).

SWEDEN.
- *Stockholm:* Eriksson (1890, Fung. Paras. Scand., Nos. 211, 280, 282), Ludwig (1892).
- *Upland:* Eriksson (1896 *a*, 1896 *b*).
- *Vestergotland:* Norstedt (N. Y. [a]).
- *Westmanland:* Nilsson (1893), Romell (Fung. Exsicc. Scand., Nos. 150, 151).

DENMARK. Oersted (vide Magnus, 1873 *b*), Rostrup (vide Magnus, 1874 *a*), Lind (P. C.[b]), Von Thümen (Myco. Univ., No. 146).

RUSSIA.
- *Baltic Provinces:* Dietrich (1856).
- *Esthonia:* Gobi and Tranzschel (1891).
- *Finland:* Hisinger (1876), Karsten (vide Von Thümen, 1880 *b*), Gobi and Tranzschel (1891).
- *Kazan:* Sorokin (vide Körnicke, 1877).
- *Kursk:* Jaczewski (1904, 1906), Bondarzev (1906, vide Jaczewski, 1904).
- *Kursk and Charkow:* Potebnia (1907).
- *Livonia:* Bondarzev and Bucholtz (1903), Jaczewski (1904, 1908).
- *Moscow:* Stephankowo (vide Sorokin, 1876 *a*), Hennings (1903), Rabenhorst (Fung. Europ., No. 2381).
- *Novgorod:* Jaczewski, Komarov, and Tranzschel (Fung. Ross. Exsicc., No. 68).
- *Orlov:* Jaczewski (1906, 1908).
- *Poland:* Jaczewski (1904).
- *St. Petersburg:* Regel (vide Sorokin, 1876 *a*), Woronin (vide Sorokin, 1876 *a*), Gobi and Tranzschel (1891), Iwanoff (1900), Tranzschel (vide Magnus, 1902), Jaczewski (1904, 1908).
- *Tiflis:* Speschneff (1899).
- *Tula:* Nawaschin (vide Schellenberg, 1904), Jaczewski (1906).
- *Ural Mountains:* Schell (vide Sorokin 1876 *a*), Sorokin (1876 *a*).
- *Voronej:* Jaczewski (1908).

SIBERIA.
- *Inja River:* Von Thümen (1880 *a*, Myco. Univers., No. 2049).
- *Minussinsk:* Roumeguère (Fung. Sel. Exsicc., No. 4518).
- *Tomsk:* Jaczewski (1904).

AUSTRIA-HUNGARY.
- *Bohemia:* Bubák (1897, 1908), Kornauth (1904, 1907), Migula (Krypt. Germ., etc., No. 57).
- *Salzburg:* Fritsch (In Fl. Exsicc. Austr.-Hung., No. 2367).
- *Tyrol:* Kornauth (1907).

ITALY.
- *Lombardy:* Turconi (1908).

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[a] The abbreviation "N. Y." when used in this list indicates that a specimen is in the herbarium of the New York Botanical Garden.

[b] The abbreviation "P. C." when used in this list indicates that a specimen is in the pathological collections of the Bureau of Plant Industry, U. S. Dept. of Agriculture.

Switzerland. Fischer (1898 *a*, 1898 *b*, 1900, 1904), Schellenberg (1904), Rikli (1909), Krieger (Fung. Saxon., No. 767).

German Empire.
Alsace: Schüle (1904, 1905).
Baden: Von Tubeuf (1898 *a*), Oppenau (1905).
Bavaria: Von Tubeuf (1897 *a*, 1898 *a*), Weiss (1901, 1904).
Brandenburg: Magnus (1873 *b*, 1891 *a*, 1902), Hartig (vide Von Thümen, 1880 *b*), Sorauer (1893, 1902), Jaap (1900, 1904), Hennings (1902 *a*), Appel (1906), Sydow (Myco. March., Nos. 832, 1117, 1524, 1631, 1632, 2753, 2754, 2755, 2756, 2757, 2758, 3031, 3449, 3450, 3451, 3452, 3453, 3454, 3716, 3717).
Bremen: Klebahn (1887, 1888 *b*), Frank and Sorauer (1893), Von Tubeuf (1898 *a*), Rabenhorst-Winter (Fung. Europ., No. 3705 *a*), Sydow (Uredineen, No. 291).
East Prussia: Körnicke (1877).
Hamburg: Smith (1898), Von Tubeuf (1898 *a*), Klebahn (1902), Brick (1902, 1904).
Hanover: Klebahn (1887), Klugkist (1909).
Hesse: Thaler (1903), Lüstner (1905).
Lubeck: Brick (1901, 1902).
Mecklenburg: Sorauer (1899), Jaap (1905).
Oldenburg: Klebahn (1887, 1888 *b*, 1902), Brick (1901, 1902, 1904), Reh (1901, 1902).
Pomerania: Fischer von Waldheim (1872), Hartig (1874), Ewert (1903), Rabenhorst (Fung. Europ., No. 1595), Sydow (Uredineen, No. 1091).
Saxony: Staritz (1903), Endler (1904), Neger (1906, 1908), Krieger (Fung. Saxon. No. 767, 1417).
Schleswig-Holstein: Magnus (1873 *a*), Fischer (vide Von Tubeuf 1897 *a*), Smith (1898), Klebahn (1902, 1904 *b*), Pettis (1909, 1910), Von Reitzenstein (1909), Spaulding (1909 *a*, 1909 *b*, 1910 *a*, 1910 *b*).
Silesia: Schroeter (1889), Lauche (vide Magnus, 1891 *a*), Frank (1897), Aderhold (1901), Ewert (1904), Sydow (Myco. March., No. 3267).
Thuringia: Köhler (1909), Hennings (N. Y.), Bornmüller (Krypt. Exsicc. Vindobonensis, No. 1131).
Westphalia: Smith (1898), Von Tubeuf (1898 *a*), Sorauer (1901), Spieckermann (1905).
West Prussia and Posen: Schander (1910).
Wurtemberg: Kirchner (1902).

France.
Ardennes: Pechon (1907).
Meurthe-et-Moselle: Destrée (N. Y.).
Orne: Lemée (P. C.).
Paris: Griffon and Maublanc (1909).
Pas-de-Calais: Géneau de Lemarlière (P. C.).
Seine-et-Marne: Briosi and Cavara (Fung. Paras. Colt., No. 255).
Vosges: Hariot (vide Griffon and Maublanc, 1909).

Belgium. Vanderyst (1899, 1900 *a*, 1900 *b*), Nypels (1900), Marchal (1901, 1902, 1903, 1905, 1907).

Holland. Oudemans (1892), Ritzema Bos (1901), Destrée (P. C.).

England. Plowright (1892 *a*, 1892 *b*, 1893, 1898–99), Smith (1898), Rea (1902), Somerville (1909).

Scotland. Laurie (1898), Somerville (1909).

Japan. Takahashi (1906).

The known distribution in Europe covers practically all those countries which are well known mycologically. Besides, *Cronartium* *ribicola* is known from several localities in western Siberia and Japan. It can be safely stated that it occurs practically throughout Europe except in the Balkan and Hispanic peninsulas (fig. 1). It is especially abundant in Germany, Denmark, Belgium, and Holland, but when we remember that in these countries the mycological flora is best known it becomes evident that the fungus is exceedingly prevalent throughout Europe. It is apparently most common in those countries where forestry is practiced most; in these countries there are many forest-tree nurseries and consequently greater chance for the fungus to spread naturally and to be distributed in infected young pine trees.

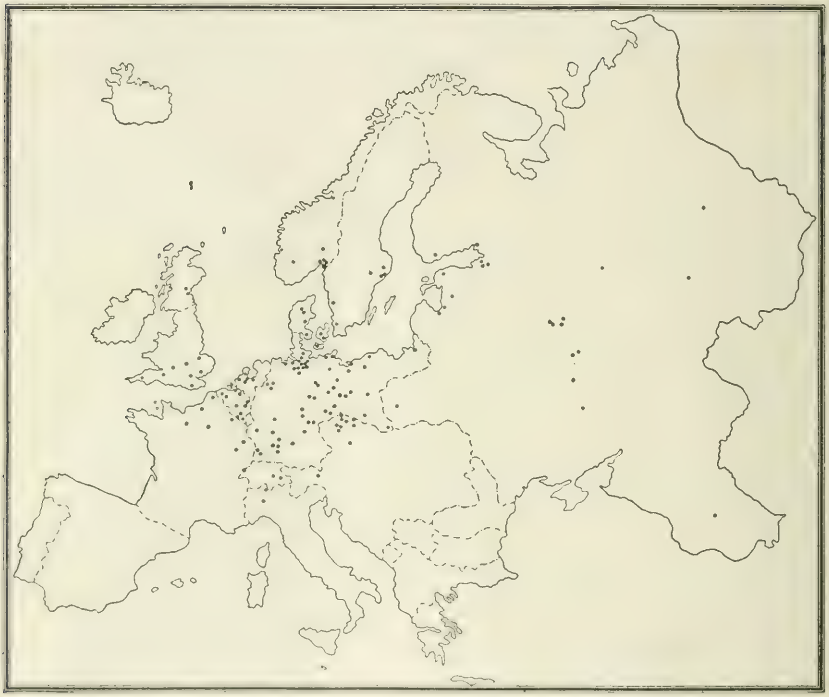

FIG. 1.—Outline map of Europe, showing the localities where *Cronartium ribicola* has been found.

CRONARTIUM RIBICOLA IN AMERICA.

Although the fungus *Cronartium ribicola* has been definitely known in America but a short time, namely, since 1906, when the Cronartium stage was first recognized by Stewart (1906), it has become widely distributed. Its first known occurrence was in Kansas in 1892, when the uredo stage was collected on *Ribes aureum*, but was not recognized until some years later. It was at the time erroneously named *Uredo confluens* Pers., but has since been identified as

Cronartium ribicola (Arthur, 1907). There is absolutely no explanation of this isolated occurrence in the middle of the American Continent. The fungus has not been found since in the same locality or anywhere in America until 1906, and there are and have been no white pines in the Kansas locality so far as is known. The uredo and teleuto stages were found by Stewart (1906) at Geneva, N. Y., on the leaves of various species of Ribes at the State experiment station. The entire Ribes plantation was pulled up and burned, and the disease apparently was successfully eradicated. In the spring of 1909 it was discovered that the æcidial stage, formerly known as *Peridermium strobi*, had been imported on several millions of young white pines from the nursery of J. Heins Söhne, of Halstenbek, Germany. Investigations to date show that the fungus has thus far been found in Kansas, New York, Pennsylvania, Vermont, New Hampshire, Massachusetts, Connecticut, Ohio, Indiana, and possibly is present in Minnesota, and in Ontario, Canada. Lots of trees from J. Heins Söhne have been distributed to 226 localities in America. The imported trees were very uniformly affected, and practically every lot of 5,000 or more of the 3-year-old white pines from J. Heins Söhne examined by the writer was found to have a number of diseased trees.

Diseased trees have been found in 1910 which were obtained of the following French firms: Levavasseur & Fils, Ussy; Barbier & Co., Orleans; and E. T. Dickinson, Chatenay.

In the late autumn of 1909 Mr. Stewart H. Burnham found *Cronartium ribicola* on *Ribes rubrum* in the vicinity of West Fort Ann, N. Y. The fungus was not identified by Mr. Burnham until the spring of 1910, when a very careful search failed to reveal the fungus on white pine or on the Ribes in the vicinity. The nearest known plantation of imported white-pine trees is 2 miles distant. It seems hardly likely that spores were carried this distance by the wind, but this is apparently the only explanation of the occurrence of the fungus there.

ECONOMIC IMPORTANCE OF THE BLISTER RUST.

BLISTER RUST ON RIBES.

The Cronartium stage on various species of currants and gooseberries is usually the most abundant and conspicuous in its effects, but the actual damage caused is not great. The rust attacks the under side of the leaves. In the uredo form the fruiting bodies are grouped in small rounded areas 1 to 5 millimeters ($\frac{1}{16}$ to $\frac{3}{8}$ inch) across, and the mycelium seems to extend but little beyond the bounds of these areas, thus involving only slightly the leaf tissues. When the attack is light, so that the pustules are scattered, the leaf is but little affected. When the attack is intense the pustules become crowded thickly together, and a considerable proportion of the leaf tissue is affected; this leads to the premature death of the leaf and its fall from the plant, the earliness of this depending upon the season of the attack and its intensity. Badly diseased bushes thus become prematurely defoliated, and are weakened to a greater or less extent. They apparently usually survive, however, there being few statements to the contrary (Jaczewski, 1904, 1905, 1906, 1908). This is probably due to the fact that the disease is not known to live over winter on Ribes, and thus continue its attacks from year to year with increasing severity. There are cases, however, which apparently can be explained in no other way than by the fungus living over winter on the youngest wood of the Ribes bushes (Stewart, 1906, and Nilsson, 1893) or else on dead leaves which remain all winter on the bushes, but such persistence has not been demonstrated.[a] The worst features of the Cronartium stage are that it apparently is not limited to a few species of Ribes, but may attack all of the numerous species more or less indiscriminately, and is thus a most efficient means of distributing the fungus to the pines, where the real damage is done.

BLISTER RUST ON PINES.

The Peridermium stage is the one in which the chief damage is done. The fungus lives year after year in the bark of the pine, extending its field of action until the stem or branch is girdled and the tree or branch above the swelling dies outright. The fungus is sure to kill its host tree if the attack is on the stem, since even if the tree survives until it is twenty-five or thirty years old it becomes relatively weak at the place of attack, and finally breaks over in some heavy wind (Pechon, 1907). Most of the young trees which are attacked on the stem die the first season that the fungus forms æcidiospores. Yet a considerable number survive, and a constantly decreasing number is left each year. Upon such remnants of the original diseased stock the fungus fruits each succeeding year, thus obtaining multiplied chances for perpetuating itself upon any Ribes bushes that may be in the vicinity. Far the greatest damage is caused by the dying of young trees in nurseries, plantations, and young reproduction growths. The fungus occurs on older trees quite often, however, but attacks only the younger branches and twigs. Where the attacks are severe, old trees may be entirely killed, but such cases are apparently exceptional. The fungus seems to be unable to infect the bark which is more than twenty years old (Hess, 1900). The great uncertainty caused by the fungus incubating for one or more years before showing evidence of disease makes it especially difficult to eliminate from an infected lot of trees.

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[a] The writer has found the æcidial stage of *Puccinia albiperidia* Arthur, which commonly attacks only the leaf blades of Ribes, upon the petioles and occasionally even upon the young twigs of *Ribes prostratum*.

This disease is essentially a disease of young trees, and especially of nursery stock. In Europe the total cumulative loss has reached 100 per cent in some instances, and there are numerous cases where it was one-third the total number or more. Instances have been found where the cultivation of *Pinus strobus* had to be discontinued because of this disease. (Klebahn, 1889; Ritzema Bos, 1901; and Smith, 1898.) The most common way for the Peridermium stage of the fungus to be distributed is in infected nursery stock, it often being sent thousands of miles in this manner. (Thaler, 1903; Weiss, 1899; Von Tubeuf, 1898 *a;* Klebahn, 1904 *a;* Smith, 1898; Pettis, 1909, 1910; and Spaulding, 1909 *a*, 1909 *b*, 1910 *a*, 1910 *b*.)

Many more or less definite statements have been found of the occurrence of this disease in European nurseries, but in most cases the nursery is not named. The following German nurseries are known to have had the disease upon pine or Ribes at approximately the dates indicated: J. Heins Söhne, Halstenbek (Holstein) in 1904–1910 (personal observations on trees imported from this firm); Späth, Berlin, in 1887–1895 (Sydow, specimens issued in his "Uredineen" and "Mycotheca Marchica"); H. C. A. Helleman, Moorende (near Lilienthal, Hanover) in 1886–7, (Klebahn, 1887); Metz & Co., Steglitz, near Berlin, in 1887–9 (Magnus, 1891 *a*); H. H. Pein, Halstenbek (Holstein), "several years ago" (Von Reitzenstein, 1909). There are a number of less definite statements indicating that the disease has occurred in nurseries at or near the following places: *Germany:* Berlin, Brandenburg (Sorauer, 1902); Muskau, Silesia (Magnus, 1891 *a*); Eberswalde, Brandenburg (Magnus, 1902); Amelsbüren, Westphalia (Spieckermann, 1905); Delmenhorst, Oldenburg (Klebahn, 1887); Tharandt, Saxony (Neger, 1908); Hamburg (Smith, 1898); Mühlenbeck (Von Tubeuf, 1897 *a*). *France:* Paris (Griffon and Maublanc, 1909). *Sweden:* Stockholm (Eriksson, 1890). *Russia:* St. Petersburg (Magnus, 1902).

Diseased trees have been shipped to America from three French firms already mentioned: Levavasseur & Fils, Ussy; Barbier & Co., Orleans; and E. T. Dickinson, Chatenay. It is not known whether the trees were grown by these firms.

In America the opportunity to obtain data on the damage caused by *Cronartium ribicola* has fortunately been very limited. In a large lot of imported 3-year-old pines an actual count showed that exactly 1 per cent were visibly diseased the first season that the fungus appeared. It is estimated that about 500 trees were destroyed in another lot of 50,000 of the same age, while in another case over 300 were destroyed out of 2,000, and probably many more should have been destroyed, as fully half of those set in the field have since died. Other lots have shown percentages of 0.2 to 3 of visibly diseased trees.

There are many definite statements of damage caused in various European countries, as follows:

Plowright (1892 *b*) first found the fungus in England in 1892. Smith (1898) says that reports of the disease are frequent upon *Pinus strobus*, and that the disease is being distributed from Germany, whence nursery stock is imported. He also states that it became so serious in a large nursery in Westphalia, near the Holland frontier, that the stock was destroyed and the use of this species was discontinued for a time; also that the disease is common in many nurseries around Hamburg, and that a supply of white pines from a nursery in Holstein and used near Lake Constance had to be removed and burned in less than two years.

Somerville (1909) says of the situation in England:

> This disease is so much on the increase that it is not too much to say that the outlook in this country for the Weymouth (white) and other five-leaved American pines is almost hopeless. * * * But it is to be feared that the day is not far distant when it will gain a footing in North America, and if it spreads there, as it has done in Europe, the loss that will result through the destruction of one of America's most valuable lumber trees can only be described as appalling. On the Weymouth and similar pines, on the other hand, it is so fatal that there are estates in Britain (e. g., Murthly in Perthshire and Woburn in Bedfordshire) where hardly a living example of *P. strobus* or *P. monticola* is left, at least of the younger classes.
>
> It is not pleasant to have to give this opinion, but anyone who has seen the condition of things on the estates mentioned or in the Crown woods near Windsor and Ascot must realize how hopeless is the future of the Weymouth pine in this country.

The fungus was first noted in Sweden in 1887, and has appeared every spring since. Eriksson (1890) says that at first it attacked only young trees, but in 1889 it also attacked quite large ones. Nordstedt (1888) found both stages in large quantities in Vestergotland.

In Denmark, Rostrup (1883) says that *Peridermium strobi* on *Pinus strobus* causes more damage than any other species of bark-inhabiting Peridermium.[a]

In Finland, Hisinger (1876) found 30-year-old trees of *Pinus strobus* diseased and finally killed by *Peridermium strobi* upon their stems. Dietrich (1856) says that affected trees of *Pinus strobus* seen by him in the Baltic Provinces of Russia were mostly killed in a few years. Tranzschel (vide Magnus, 1902) found young plants of *Pinus cembra* in the nursery of the St. Petersburg Royal Forestry Institute so seriously attacked by this disease that entire beds were killed.

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[a] While on a recent visit to this country, Prof. Dr. F. K. Ravn, of Copenhagen, Denmark, orally informed us that the white pine would be very successful in Denmark were it not for the attacks of this fungus. The blister rust, however, has caused the virtual abandonment of the use of this species in that country.

German writers have often mentioned the damage caused by this fungus. Brick (1901) says that the Peridermium stage occurs in the forests of Lübeck. Ewert (1903) found it very widespread in the protective planting of the Royal Pomeranian Institute, so that one tree after another became affected. Even old trees were not exempt. Hennings (1902 *a*) found the Cronartium stage abundant year after year about Berlin. Hess (1900) says that the disease is very destructive to white pine, the stem and branches above the thickened part dying as a rule. He also says the stems of 20 to 25 years or older seem not to become diseased. Klebahn (1887, 1888 *b*) found approximately 30 per cent of all the white pine trees in the Bremen city park affected by *Peridermium strobi*. Of the diseased trees about 47 per cent were attacked on the stem. The affected trees were partly scattered and partly in patches. The large trees were usually attacked only on the branches. A single tree of *Pinus lambertiana* was found diseased also, while trees of *P. silvestris*, *P. nigricans*, *P. cembra*, and *P. mughus* were not affected. He mentions an instance where an entire lot of 1,000 4-year-old white pine trees were destroyed by *Peridermium strobi*. The disease occurred in the nursery of H. C. A. Helleman, at Moorende, near Lilienthal, and affected 16 per cent of the white pine trees. He noted it near Delmenhorst in considerable quantity and received specimens from Schwarze Berge in Hanover. He also says that this species is earlier than other native Peridermia, fruiting from April 25 to June 10. Köck (1908 *b*) speaks of it as a "very injurious disease." Köhler (1909) found that the larger part of the white pines in the Altenburg park were dying from attacks of this fungus. He also says its eradication is difficult and laborious. Magnus (1891 *a*, 1891 *b*, 1902) says that both forms occur destructively, as he has repeatedly observed. He also especially mentions its occurrence very abundantly on Ribes in the nursery of Metz & Co., at Steglitz, near Berlin, and on white pine in nurseries at Muskau, where 800 young trees were destroyed. Magnus also noted the disease for several years in the nursery of the Royal Forest Academy at Eberswalde. Neger (1906, 1907, 1908) found some 18-year-old trees of *Pinus monticola* at the Royal Forest Academy at Tharandt affected with *Peridermium strobi*, and he mentions this as causing the most destructive disease of *Pinus strobus* in Europe. The blister rust is said by Von Reitzenstein (1909) to have caused discrimination against white-pine stock from Halstenbek several years ago. The diseased trees were burned and the fungus is said to be unknown there now. While this statement may be true for the nurseries of H. H. Pein, about which he was writing at the time, it is decidedly untrue of those of J. Heins Söhne, as is shown by the large numbers of diseased trees shipped thence to America in 1908 and 1909.[a] Sorauer (1902) found young white pines seriously attacked by *Peridermium strobi* in a nursery near Berlin. Spieckermann (1905) mentions the occurrence of this disease in a nursery at Amelsbüren, where it killed numerous white-pine trees from 2 to 4 years old. Thaler (1903) says that in Hesse a number of head foresters reported *Peridermium strobi* occurring on stock bought of private nurseries. In one case the number of diseased trees was about 1 per cent of the whole. Thaler advises the buying of white-pine stock from private nurseries with caution. Von Tubeuf (1897*a*, 1898*a*, 1905*a*) mentions a number of other fungi destructive to *Pinus strobus* in Europe, but says that *Peridermium strobi* is the most destructive of all, killing branches and whole stems. It is distributed on young trees and thus becomes scattered in places where it previously did not occur. In a forest of Westphalia he found many small trees diseased, and in one of the largest nurseries near the Holland boundary he found the culture of white pine was wholly given up because of this disease. He says it is widespread about Hamburg and is distributed thence in nursery stock. He also mentions finding it in a nursery at Mühlenbek and in a park at Bad Kohlgrub. It is constantly spreading and causing more damage, and is difficult to eradicate. Weiss (1899) says that epidemics of the disease may easily occur where Ribes and white pines are raised in the same nursery; also that owners of nurseries should take pains that only healthy stock be sent out, since the disease is very often spread by the sending out of plants which are already infected.

In Bohemia, Bubák (1908) states that the æcidia are formed from the middle of April to June. He also mentions the disease as killing young trees of *Pinus strobus* planted in the field.

Schellenberg (1904) found *Peridermium strobi* on *Pinus cembra* in Switzerland, probably in the same locality where Fischer found the Cronartium stage in 1895. In this case it attacked a 15-year-old branch of a tree 200 years old, and had evidently infected the branch 10 to 12 years previously. Schellenberg concludes that this shows that the fungus is endemic in the Alps.

Griffon and Maublanc (1909) found the disease on *Pinus strobus* plants 4 or 5 years old, in a large nursery in the suburbs of Paris. They also say that the fungus in 1908 caused great damage in the forest of Fontenoy. Pechon (1907) states that when pine plants of 2 to 8 years are seriously attacked they usually die, while older ones continue to sprout; but that when the affected tree lives to be about 35 years old the weight of the top becomes too much for the weakened stem and a heavy wind breaks it over. He also says that older trees often become partly or entirely decrowned by the killing of the smaller branches and that the disease is common in Ardennes and should be vigorously combated. Marchal (1901) finds the fungus common in Belgium in both stages and states that the disease incubates for one year to several years. Nypels (1900) says that this disease has spread rapidly throughout Belgium in the last few years. Ritzema Bos (1901) states that the fungus is so prevalent in Holland that the culture of white pine is impossible.

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[a] Moreover, stock has been received from this firm in this country during the spring of 1911, which, when unpacked, bore fruiting bodies of the blister rust.

HOSTS OF CRONARTIUM RIBICOLA.

THE NORTH AMERICAN AND FOREIGN SPECIES OF FIVE-LEAVED PINES.

The æcidial or Peridermium stage of *Cronartium ribicola* has been found only on species of pine belonging to the 5-leaved group. This is sometimes called the Strobus or white-pine group. Trees of *Pinus strobus* only have been found diseased in America. In Europe, trees of *Pinus cembra*, *P. strobus*, *P. monticola*, *P. lambertiana*, and *P. excelsa* have been found affected by this fungus. Apparently no inoculation experiments have been made with other species, so that our knowledge in this respect is deficient. The fungus is apparently native on *P. cembra*, but has attacked the three American and the single Asiatic species of the Strobus group which have been exposed to infections while no species of the other groups are affected, although they have been present in proximity to diseased *P. strobus*. There is every reason to believe that other species of the Strobus group may become hosts of this fungus under favorable circumstances.

The possible host species are as follows:

NORTH AMERICA.

Name.	*Range.*
1. *Pinus ayacahuite* Ehrenb	Southern Mexico into Guatemala.
2. *Pinus strobiformis* Engelm.	Southern Arizona into Chihuahua, Mexico.
3. *Pinus flexilis* James	Rocky Mountain region.
4. *Pinus albicaulis* Engelm	British Columbia and Alberta to Montana, Wyoming, Washington, Oregon, and southern California.
5. *Pinus balfouriana* Murray	California.
6. *Pinus aristata* Engelm	High peaks from Colorado to southern Utah, Nevada, southeastern California, and northern Arizona.
7. *Pinus strobus* L	Newfoundland to Pennsylvania, along the Appalachians to Georgia, west to eastern Iowa and Minnesota; in Canada from Lake Winnipeg to northern shore of St. Lawrence Gulf and Newfoundland.
8. *Pinus monticola* Douglas	Montana and southern British Columbia to Washington, Oregon, and California.
9. *Pinus lambertiana* Douglas.	Oregon through California to Lower California and Mexico.

FOREIGN COUNTRIES.

Name.	*Range.*
10. *Pinus excelsa* Wall.	Himalaya Mountain region.
11. *Pinus peuce* Gris.	Montenegro, Bulgaria, and Balkan Mountains.
12. *Pinus scipioniformis* Mast.	Central China.
13. *Pinus pentaphylla* Mayr.	Japan.
14. *Pinus parviflora* Sieb. and Zucc.	Japan.
15. *Pinus pumila* Rgl.	Northeastern Siberia and Japan.
16. *Pinus koraiensis* Sieb. and Zucc.	Japan, Korea, Kamchatka, Manchuria, western China, and Formosa.
17. *Pinus armandii* Franch.	China.
18. *Pinus cembra* L.	In Alps, Carpathians, Urals, northern Russia, and Siberia.

A glance at the territory included within the combined ranges of these species shows that a large part of the entire north temperate region is covered. The disease is at present known to occur nearly throughout Europe, in the western part of Siberia, and now occurs in the Eastern States of this country, as well as in Ontario, Canada. So far as we know the fungus might be able to attack any or all of these species, and might become distributed in time to practically all parts of the north Temperate Zone.

The Cronartium stage, including both the uredo and teleuto forms, occurs only on the leaves of the various species of Ribes. A Cronartium has been reported (Tulasne, 1854) on Ribes in India, but it is uncertain whether it is *C. ribicola*. Records have been found showing the occurrence of this fungus on about twenty-five distinct species of Ribes, besides numerous horticultural and botanical varieties or subspecies. The accompanying diagram (fig. 2)[a] shows the transfer of the fungus from the three species of pine to the various species of Ribes, so far as this is definitely known.

KNOWN HOST SPECIES OF RIBES.

Cronartium ribicola has been collected and reported as occurring on the following species of Ribes:[b]

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[a] (1) Hennings, 1902 *b;* (2) Fischer, 1904, for *Pinus cembra;* Hennings, 1902 *b* for *Pinus strobus;* (3) Ewert, 1903; Hennings, 1902 *b;* (4) Jaap, 1905, for *Pinus cembra;* Blytt, 1896, Bubák, 1908, Ewert, 1903, Hennings, 1902 *b*, for *Pinus strobus;* (5) Hennings, 1902 *b;* (6) Hennings, 1902 *b;* (7) Hennings, 1902 *b;* (8) Ewert, 1903, Hennings, 1902 *b*, Rostrup, 1902; (9) Bubák, 1908, Ewert, 1903, Hennings, 1902 *b;* (10) Hennings, 1902 *b*, Rostrup, 1902; (11) Bubák, 1908, Hennings, 1902 *b;* (12) Hennings, 1902 *b*, Rostrup, 1902; (13) Iwanoff, 1900, Jaap, 1900, 1904, Magnus, 1902, for *Pinus cembra;* Blytt, 1896, Bubák, 1908, Ewert, 1903, Hennings, 1902 *b*, Jaap, 1905, Klebahn, 1902, Magnus, 1902, for *Pinus strobus;* (14) Hennings, 1902 *b;* (15) Fischer, 1898, 1904, for *Pinus cembra;* Hennings, 1902 *a*, for *Pinus strobus;* (16) Hennings, 1902 *b;* (17) Hennings, 1902 *b;* (18) Jaap, 1900, for *Pinus cembra;* Bubák, 1908, Hennings, 1902 *b*, for *Pinus strobus;* (19) Bubák, 1908, Ewert, 1908, Hennings, 1902 *b*, for *Pinus strobus;* Neger, 1908, for *Pinus monticola;* (20) Hennings, 1902 *b;* (21) Hennings, 1902 *b*.

[b] The Index Kewensis is followed in naming the Ribes.

aciculare Sm. Hennings (1902 *a*); Klebahn (1904 *a*).

alpinum L. Fischer (1904); Klebahn (1890 *b*, 1892 *a*); Sorauer (1891); Staritz (1903); Von Tubeuf (1901 *a*); Sydow (Uredineen, No. 381); Sydow (Myc. March., No. 1631).

americanum Mill. Ewert (1903); Hennings (1902 *a*); Klebahn (1904 *a*); Magnus (1902); Sorauer (1891); Von Tubeuf (1901 *a*).

aureum Pursh. Arthur (1907); Bartholomew (1899); Blytt (1896); Brick (1902); Bubák (1897, 1908); Ewert (1903); Fischer von Waldheim (1872); Frank and Sorauer (1893); Gobi and Tranzschel (1891); Hennings (1902 *a*, 1902 *b*); Jaap (1905); Klebahn (1890 *b*, 1892 *a*); Magnus (1873 *a*); Sorauer (1891); Sorokin (1876 *b*); Stewart (1906); Von Tubeuf (1901 *a*); Winter (1880); Sydow (Myc. March., No. 832); Sydow (Uredineen, No. 89, 1090); Eriksson (Fung. Paras. Scand., No. 280); Rabenhorst-Winter (Fung. Europe, No. 3705 *b*); Migula (Krypt. Germ., etc., No. 57); Krieger (Fung. Saxon., No. 1417); Krieger (Schadl. Pilze, No. 115); Klebahn and Magnus (P. C.).

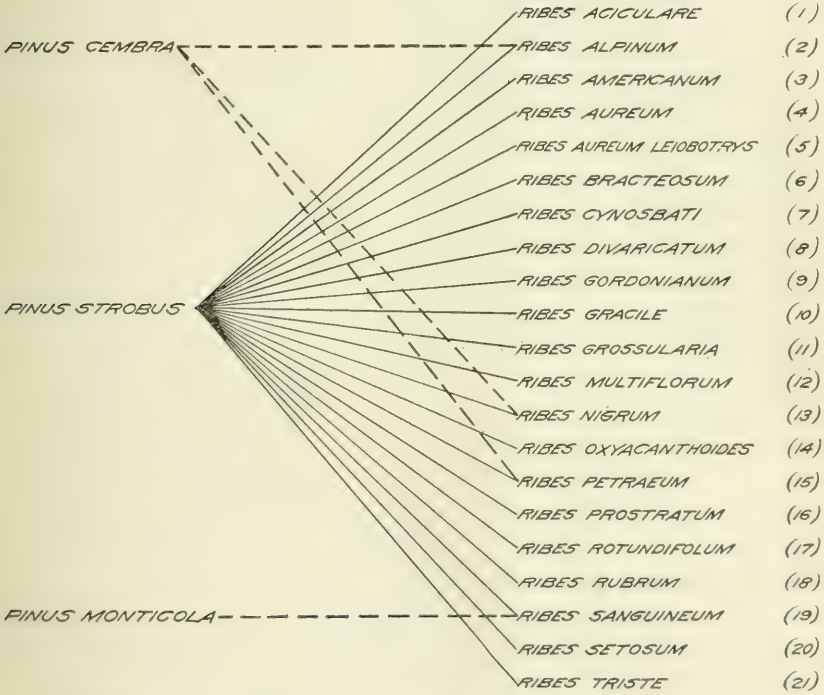
PINUS CEMBRA
PINUS STROBUS
PINUS MONTICOLA
RIBES ACICULARE (1)
RIBES ALPINUM (2)
RIBES AMERICANUM (3)
RIBES AUREUM (4)
RIBES AUREUM LEIOBOTRYS (5)
RIBES BRACTEOSUM (6)
RIBES CYNOSBATI (7)
RIBES DIVARICATUM (8)
RIBES GORDONIANUM (9)
RIBES GRACILE (10)
RIBES GROSSULARIA (11)
RIBES MULTIFLORUM (12)
RIBES NIGRUM (13)
RIBES OXYACANTHOIDES (14)
RIBES PETRAEUM (15)
RIBES PROSTRATUM (16)
RIBES ROTUNDIFOLUM (17)
RIBES RUBRUM (18)
RIBES SANGUINEUM (19)
RIBES SETOSUM (20)
RIBES TRISTE (21)

FIG. 2.—Diagram showing transfers of *Cronartium ribicola* from the pines to various species of Ribes The numbers in parentheses refer to the authorities cited in the footnote on p. 22.

aureum var. *leiobtrys* Zabel. Hennings (1902 *a*); Klebahn (1904 *a*).

aureum var. *palmatum* Desf. Dietrich (1856); Gobi and Tranzschel (1891).

bracteosum Douglas. Hennings (1902 *a*); Klebahn (1904 *a*).

cynosbati L. Hennings (1902 *a*); Von Tubeuf (1901 *a*); Vestergren (Micro. Rar. Sel., no. 476); Rabenhorst-Pazsche (Fung. Europ. and Extra, No. 4311).

divaricatum Douglas. Ewert (1903); Hennings (1902 *a*); Rostrup (1895); Von Tubeuf (1901 *a*).

gordonianum Lem. Bubák (1908); Ewert (1903); Hennings (1902 *a*); Klebahn (1904 *a*); Rabenhorst-Pazsche (Fung. Europ. and Extra., No. 4312).

gracile Michx. Klebahn (1904 *a*); Rostrup (1895); Sydow (Myc. March., No. 3716); Sydow (Uredineen, No. 592).

grossularia L. Brick (1902); Bubák (1908); Hennings (1902 *a*); Klebahn (1895 *a*); Poirault (1890); Speschneff (1899); Stewart (1906); Sydow (Myc. March., No. 1632); Krieger (Fung. Saxon., No. 1907).

grossularia var. *arboreum* Hort. Sydow (Uredineen, No. 383).

heterophyllum Phil. Hennings (1902 *a*); Klebahn (1904 *a*); Rabenhorst-Pazsche (Fung. Europ. and Extra., No. 4111); Sydow (Uredineen, No. 591); Sydow (Myc. March., No. 3452); Vestergren (Micro. Rar. Sel., No. 476).

intermedium Tausch. Sydow (Uredineen, No. 241); Sydow (Myc. March., No. 2757).

macrobotrys Ruiz. and Pav. Sydow (Uredineen, No. 594); Sydow (Myc. March., No. 3451).

menziesii Pursh. Sydow (Uredineen, No. 983).

multiflorum Kit. Hennings (1902 *a*); Klebahn (1904 *a*); Rostrup (1895).

nigrum L. Rostrup (1874); Blytt (1896); Bondarzev (1906); Bondarzev and Bucholtz (1903); Brick (1902); Bubák (1908); Deitrich (1856); Eriksson (1896); Ewert (1903); Frank and Sorauer (1893); Hennings (1902 *a*); Iwanoff (1900); Jaap (1900, 1904, 1905): Jaczewski (1904, 1905, 1906, 1908); Kirchner (1902); Klebahn (1888 *b*, 1890 *b*, 1892 *a*, 1897 *b*, 1902, 1904 *b*, 1905 *b*); Körnicke (1877); Magnus (1874 *a*, 1902); Marchal (1901); Nilsson (1893); Oudemans (1892); Poirault (1890); Potebnia (1907); Schroeter (1889); Sorauer (1891, 1901); Sorokin (1876 *a*); Stewart (1906); Von Tubeuf (1901 *a*); Vanderyst (1899); Weiss (1901); Winter (1880); Bartholomew (Fung. Columb., No. 2318); Eriksson (Fung. Paras. Scand., No. 211); Jaczewski, Komarov, and Tranzschel (Fung. Ross. Exsicc., No. 68); Krieger (Schadl. Pilz., No. 72); Krieger (Fung. Saxon., No. 615); Géneau de Lemarlière, Lemée and Magnus (P. C.); Migula (Krypt. Germ., etc., No. 57); Möller (P. C.); Nordstedt (N. Y.); Rabenhorst (Fung. Europ., No. 2381); Romell (Fung. Exsicc. Scand., Nos. 150, 151); Rostrup (specimen in Cryptogamic Herb., Harvard Univ.); Stewart (P. C.); Sydow (Myc. Germ., No. 159); Sydow (Uredineen, No. 41, 1091); Sydow (Myc. March., No. 1117); Von Thümen (Myc. Univ., No. 146).

nigrum var. *aconitifolium* Hort. Gobi and Tranzschel (1891); Sydow (Uredineen, No. 382).

nigrum var. *crispum* Hort. Sorauer (1891).

nigrum var. *laciniatum* Hook. Sorauer (1891).

orientale Desf. Sydow (Myc. March., Nos. 3717, 2753).

oxyacanthoides L. Hennings (1902 *a*); Von Tubeuf (1901 *a*); Rabenhorst-Pazsche (Fung. Europ. and Extra., No. 4111); Sydow (Myc. March., No. 2755).

parvifolia Phil. Sydow (Myc. March., No. 2758).

petraeum Wulf. Fischer (1898 *a*, 1900, 1904); Hennings (1902 *a*); Klebahn (1904 *a*).

prostratum L'Herit. Hennings (1902 *a*); Klebahn (1904 *a*).

rotundifolium Michx. Hennings (1902 *a*); Sorauer (1891); Von Tubeuf (1901 *a*); Sydow (Myc. March., No. 3453); Sydow (Uredineen, No. 597).

rubrum Linn. Arthur (1907); Bondarzev (1906); Bubák (1897, 1908); Dietrich (1856); Gobi and Tranzschel (1891); Hennings (1902 *a*); Jaap (1900); Jaczewski (1908); Kirchner (1902); Klebahn (1890 *b*, 1892); Oudemans (1892); Poirault (1890); Sorauer (1891); Speschneff (1899); Staritz (1903); Stewart (1906); Von Thümen (1880 *a*); Turconi (1908); Winter (1880); Bornmuller (Krypt. Exsicc. Vindobonensis, No. 1131); Destrée (P. C. and N. Y.); Fritsch (Fl. Exsicc. Aust.-Hung., No. 2367); Hennings (N. Y.); Krieger (Fung. Saxon., No. 1555); Roumeguère (Fung. Sel. Exsicc., No. 4518); Sydow (Uredineen, No. 845); Sydow (Myc. March., No. 1524); Von Thümen (Myc. Univ., No. 2049).

sanguineum Pursh. Bubák (1908); Ewert (1903); Hennings (1902 *a*); Neger (1908); Sorauer (1891); Von Tubeuf (1901 *a*); Krieger (Fung. Saxon., No. 2010); Lind (P. C.); Sydow (Myc. March., No. 1633.)
saxatile Pall. Sydow (Myc. March., No. 3031).
setosum Lindl. Hennings (1902 *a*); Sorauer (1891); Von Tubeuf (1901 *a*); Sydow (Uredineen, No. 599, 593); Sydow (Myc. March., No. 3454).
triste Pall. Hennings (1902 *a*); Klebahn (1904 *a*).

Of the twenty-six species here given, thirteen are American species. These in their wild state include the larger part of North America within their ranges. But those regions in which the wild species do not occur are well supplied with cultivated ones. One can scarcely doubt that *Cronartium ribicola* in time would spread throughout the continent should it once become well established in any one State.

At various times different investigators (Schroeter, 1875; Sorokin, 1876 *b;* Sorauer, 1891; Klebahn, 1892 *a*, 1893 *a*, 1895 *a;* Brick, 1902; Hennings, 1902 *a;* Ewert, 1903, 1904; Appel, 1906; Neger, 1908) have noted the apparent immunity of certain species of Ribes to the disease. Such species are *Ribes grossularia, R. sanguineum, R. alpinum, R. pennsylvanicum* Lam., *R. saxatile* Pall., *R. rigens* Hort., and *R. missouriense* Nutt. On the other hand, other observers have found those species which seem most nearly immune rusted somewhat. *R. grossularia* seems to be least affected of any species upon which observations have been made by a number of different investigators, but it is not always immune. Poirault (1890) cites it as affected and Klebahn (1895 *a*) made successful inoculations upon *R. grossularia* which had been grafted on *R. aureum.* The writer has made successful inoculations on the variety of *R. grossularia* known as "Triumph."

While there are some species of Ribes which are nearly or quite immune, there are others which are especially susceptible. *Ribes nigrum, R. aureum,* and *R. rubrum* have been reported by most observers as most seriously diseased. Probably this susceptibility is in some degree due to the fact that these species are the ones most commonly cultivated, and hence the disease is more often noted on these species than on wild ones.

As previously stated, the possible hosts of *Cronartium ribicola* in the genus Pinus are well distributed throughout the north temperate zone. But the genus Ribes has an even wider and more universal distribution. The species of the world are about fifty in number.[a] Throughout the territory covered by their combined ranges the wild species are almost ubiquitous. There are many species of Ribes in America, while Asia has comparatively few. The universal cultivation of Ribes in Europe makes up for the smaller number of native species there. The cultivated species are favorite garden fruits with all peoples and are found throughout the most extensive of cultivated areas. The cultivated species thus occupy just the territory which the wild ones do not. A better group of hosts could hardly be conceived for the rapid and universal distribution of a fungus over immense regions of the earth's surface.

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[a] According to Engler and Prantl's Pflanzenfamilien, vol. 3, pt. 2*a*, 1890, p. 89.

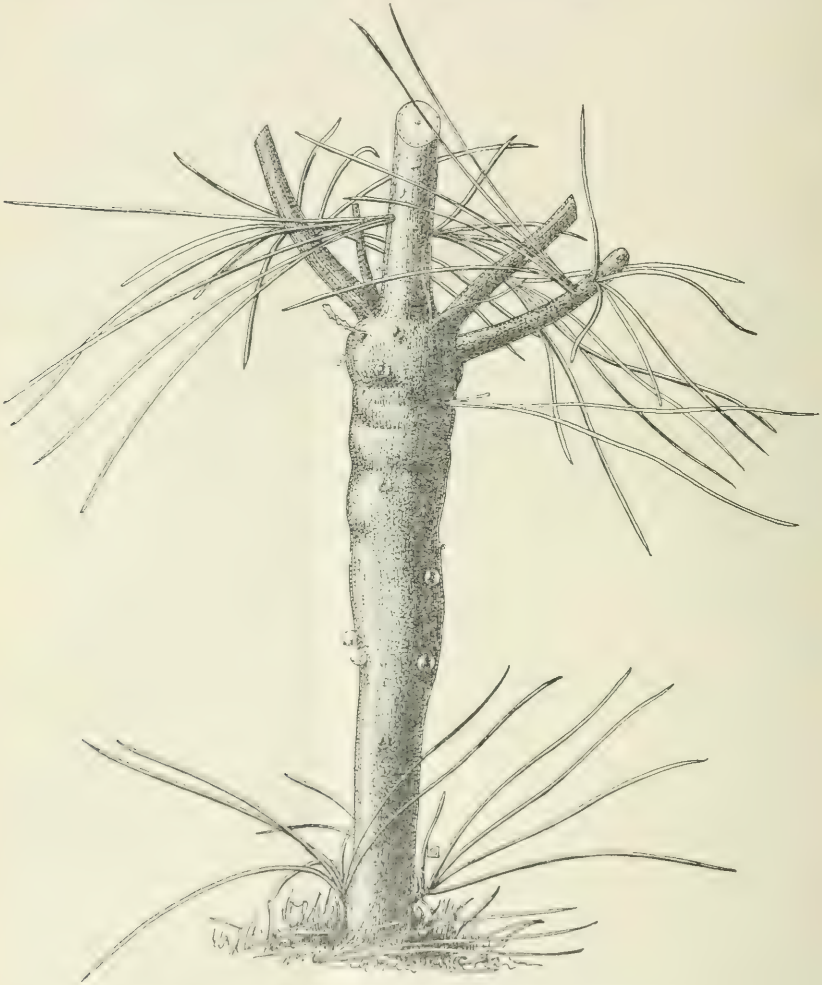

Fig. 3.—A diseased young tree of *Pinus strobus* with pycnidial drops.

LIFE HISTORY OF CRONARTIUM RIBICOLA.

The sporidia produced by the teleutospores on leaves of Ribes are blown indiscriminately by the wind to all sorts of plants which may be in the vicinity. They alight and stick to various parts of such pine trees as happen to be near by. Those which adhere to the bark of young stems or branches of five-leaved pines find congenial surroundings, and if there is sufficient moisture present for their germination they extrude a germ tube. This tube penetrates the thin young bark tissues and finds therein suitable conditions for further growth. It extends its field of action rather slowly until an area along the stem from one to several inches in length is affected. This infection of the young pines must take place after the latter part of July, as this is the earliest date on which the teleutospores have been found.

The fungus causes no external symptoms of disease in the infected pine for one to several years, at which time the inner layers of bark begin to thicken noticeably. This increase in thickness continues until the bark is often two or three times its normal thickness (Pl. II, fig. 1). In a large lot of trees, the history of which the writer knows, it was about fifteen months after the probable date of infection when hypertrophy began. After the swelling has become noticeable the pycnospores may be formed at almost any time when the weather is suitable for growth (fig. 3). Sometimes progress is slow and the disease does not become noticeable for several years. The earliest age at which pines show the disease is apparently three years, while they may be four or five years old before showing any signs of the trouble when infected in their second year. A few statements have been found that 2-year-old trees may be diseased, but the writer has seen none of this age visibly affected (Spieckermann, 1905; Pechon, 1907; Rostrup, 1902). This indeterminate period of incubation is what renders a single inspection of small value. Such an inspection will result in the removal of those pine trees which have already developed the disease far enough for it to be visible externally. Some months later there may be still other trees which will then show the disease, but which in the first inspection were apparently healthy. It will require several inspections one year apart to weed out all of the diseased trees in an infected lot. The swelling may be concentrated about a single point in the stem, in which case it changes the normal cylindrical shape to a spindle shape, usually tapering upward, but often in the reverse direction (figs. 3 and 4). In a few cases the hypertrophy extends the whole length of one year's growth of the stem, peculiar wart-like bunches forming locally, the entire affected portion having a peculiar and very characteristic obese appearance (Pl. II, figs. 1 and 2; and text fig. 3).

The pycnidia are produced from June to September, according to Klebahn, who has made the closest study of the fungus. This is probably the time when most of them appear. The writer has seen them as late as the latter part of October in the Adirondacks and has noted their appearance on plants in the greenhouse within a month after being taken from the field, i. e., the latter part of November (fig. 3). This would indicate a production of these peculiar spore bodies quite early in the spring on such plants as have shown decided swelling the previous autumn. It is likely that they appear in the spring on such plants even before the æcidia, i. e., in March or early April. This is thought to be the case, since in general the pycnidia seem to be forerunners of the æcidia, commonly maturing before the latter.

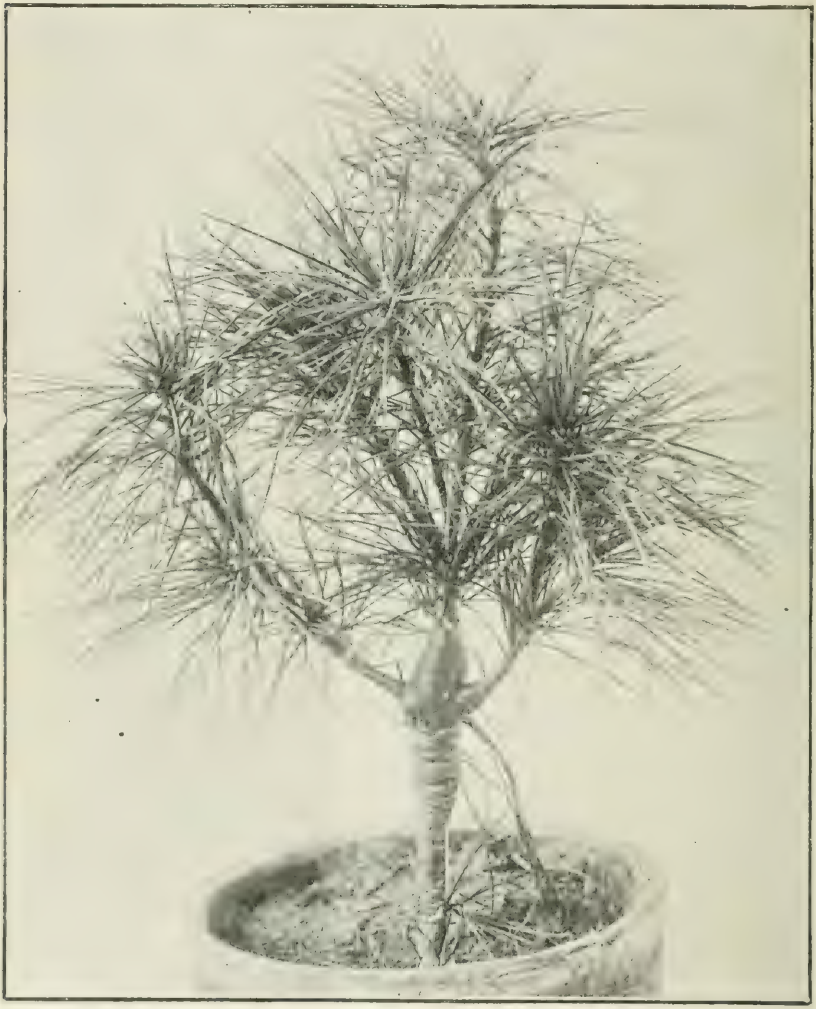

FIG. 4.—A 4-year-old white pine tree showing marked swelling extending upward in the lateral branches, as well as in the stem.

Early in the spring, after the swelling of the stem is noticeable, the æcidia are formed at one or more places on the swollen bark. If the disease has not progressed enough for the fungus to have attained much strength, only a single pustule is formed; if the fungus has made a luxuriant growth there may be 10 or 15 or more separate pustules, according to the size of the tree, located on the swollen part (Pl. I, *A*; Pl. II, fig. 2). The disease appears usually only on that part of the stem or branch which is three years old or older, i. e., that part where the leaves have been shed (Pl. I, *A*). These pustules are formed from early April (Klebahn, 1890 *b*) to the early part of June, appearing in the greatest number in the month of May. This varies much according to location and character of the season, however. They break through fissures in the bark, appearing first as rounded bodies of one-eighth to three-eighths of an inch in width and one-fourth to one half inch in length, and yellowish-white in color from the color of the orange spores within the white membranaceous peridium. After a short time the peridium breaks open irregularly, allowing the inclosed spores to fall out and be borne away by the wind (Pl. I, *A*; Pl. II, fig. 2). Klebahn (1904 *a*) states that an æcidium will produce spores for at least fourteen days. By the time in the spring that the spores are freed the young Ribes leaves are formed, so that the spores fall upon them, germinate, and infect them.

The distance to which the uredospores or the æcidiospores may be carried by the wind naturally varies with the local conditions. Plowright (1892 *b*) found diseased white-pine trees 15 yards from affected Ribes bushes. Lauche found the two hosts, both with the rust, 20 meters (66 feet) apart (vide Magnus 1891 *a*, 1891 *b*). Von Tubeuf (1901 *c*) in a paper on the distribution of fungous spores by wind mentions the known distribution of Gymnosporangium spores for several hundred meters. He speaks of two instances of the distribution of *Cronartium ribicola* (1901 *c*), in one case to a distance of 120 meters (396 feet) and in the second to 500 meters (1,650 feet) both to Ribes from *Pinus strobus*. In 1898 (Hollrung, 1898), the Prussian Ministry of Agriculture, Public Domains, and Forests issued an order requiring white pine to be planted at a distance of at least 50 meters (165 feet) from Ribes and the planting of another kind of tree between the two to prevent the wind carrying the spores from one to the other. Magnus (1891 *a*, 1891 *b*) mentions the occurrence of *Cronartium ribicola* on Ribes only 20 meters (66 feet) distant from diseased *Pinus strobus*. Hess (1900) recommends that the two host genera be separated for a distance of at least 50 meters (165 feet). Marchal (1901) recommends a distance of 30 meters (99 feet).

In the work done during 1909 in the removal of Ribes from the vicinity of white pine plantations, 300 feet or 99 meters was taken as a safe distance. In all States but Vermont Ribes were removed from that distance around the plantations. In Vermont 500 feet (151 meters) was taken as a safe distance. In 1910 New York also took 500 feet as the width of the safety zone.

The æcidiospores germinate within a few hours if there is sufficient moisture. Klebahn (1904 *a*) states that they will remain viable for five weeks, while the writer has germinated them after they had been kept dry in the peridium for five months. The supply of moisture apparently must be plentiful, for an inoculation experiment made by the writer with fresh æcidiospores on currant leaves in the open air utterly failed. The inoculated leaves were not wet, and the test was made during a drought. Nevertheless there was more or less dew nearly every night. Inoculations made by the writer with æcidiospores upon Ribes where the inoculated leaves were heavily wet and then kept under bell glasses resulted in heavy infection. Ewert (1903) says that in 1902 the weather was moist enough to favor the spread of the fungus. Schellenberg (1904) tried unsuccessfully to inoculate Ribes leaves with the æcidiospores and attributed his lack of success to sunny weather. Klebahn (1904 *a*) states that they germinate easily in a moist chamber, and in his description of inoculation experiments with the rusts shows a drawing of an elaborate moist chamber containing the plant to be used in making inoculations.

The æcidiospores can not infect pines if we may accept the evidence of other species of Cronartium. Furthermore, repeated tests made by Klebahn (1904 *a*) have resulted in total failure.

In ten to twenty-one days after infection of Ribes leaves the uredo pustules show under the epidermis and break through it on the underside of the leaves, liberating the spores (Pl. I, *B* and *C*). The uredospores serve to spread the fungus still further on Ribes, as they were believed to have the power to infect Ribes leaves. Inoculations made by Hedgcock, of the Bureau of Plant Industry, with uredospores upon Ribes have proved this to be true. In this way a few scattering infections by æcidiospores may lead to very plentiful and heavy infection of all Ribes in the vicinity. The uredospores are produced in tiny pustules which break through the epidermis and form small masses of the yellow spores heaped up in tiny rounded piles above the level of the epidermis (Pl. I, *C*). They are mainly distributed by the wind, but insects probably carry them to other leaves and near-by plants. The uredospores will germinate at once, producing a simple germ tube similar to that of the æcidiospore; indeed, the uredospores resemble the æcidiospores so much in many ways that Klebahn discussed them together under the same heading in "Die Wirtswechselnden Rostpilze," not distinguishing between the two in many statements. How long the uredospores may retain viability is uncertain, but probably as long as the æcidiospores under the same conditions. The length of time from infection with uredospores to the formation of new uredospores is about fourteen days, the above-mentioned inoculations yielding results in this time. It is always stated that the uredospores infect only the leaves of currants and gooseberries. There is reason to think that the rust may occasionally live over winter on Ribes, but the leaves are shed every autumn and there seems to be no adequate way of explaining such possible overwintering except by the formation of uredo pustules on the young shoots. The finding by the writer of spore pustules on young twigs of a plant of Ribes which was attacked by a leaf-inhabiting Puccinia (see footnote, p. 16) seems to indicate the correctness of this supposition. The uredospores have been found from the latter part of May (Magnus, 1891 *a*) to the time of the shedding of the Ribes leaves.

After a few weeks yellow to brown threadlike outgrowths form in the uredo pustules (Pl. I, *D*). These are the Cronartium filaments upon which the teleutospores are borne. In artificial inoculations on Ribes leaves the teleutospores have been formed about six weeks after the infection took place (Klebahn, 1888 *b*). They have been found occurring naturally in the field from July (Schroeter, 1889; Von Tubeuf, 1898 *b*) to the fall of the leaves and even on the fallen leaves. The teleutospores may germinate at once; how long they may retain viability is unknown, but presumably for a considerable period of time. When germination takes place, a simple germ tube is extruded and this soon produces a number of simple, thin-walled, cylindrical to ovoid conidia or sporidia. These are blown to neighboring white-pine trees, there to begin again the complicated life cycle of the fungus. The sporidia apparently must be distributed very largely by the wind. Owing to the long time elapsing between infection and the first appearance of disease (one to several years), little or no definite knowledge exists concerning the distance to which these spores may be carried. Commonly rusted Ribes are found quite near diseased pine trees, so it seems likely that this form of spore is not very widely distributed from the center of production. We are also ignorant as to the power which the sporidia possess of surviving desiccation. They are so thin walled that it seems likely that they will survive but a slight degree of dryness. Should this be true, their fields of efficiency would be very much restricted, since their chief means of distribution would usually be a factor in producing unfavorable dryness. Possibly insects play a small part in carrying them to neighboring plants, but so far as we know this takes place only accidentally.

The evidence all seems to favor the view that any or all forms of spores of *Cronartium ribicola* may infect the host plants in uninjured tissues. The Uredinales are among the most strictly parasitic of the fungi. Infection may probably take place at any time when the spore comes in contact with the proper part of the proper host, provided suitable conditions for germination occur. These conditions for germination are a sufficient amount of moisture and heat,

NOMENCLATURE OF CRONARTIUM RIBICOLA.

THE SCIENTIFIC NAME.

In 1856 Dietrich first used the name *Cronartium ribicola* in a publication. Here it was used without any description, and hence is apparently a *nomen nudem* and invalid. But Dietrich referred to "Crypt. 4:21," evidently meaning some set of exsiccatæ containing specimens of the fungus. In 1852–1857 Dietrich issued such exsiccatæ entitled "Plantarum Florae Balticae Cryptogamarum." It is almost certain that the reference mentioned above refers to these exsiccatæ. Whether the specimen of *Cronartium ribicola* in these exsiccatæ had a description upon the label is unknown. That this is the case seems very probable when we remember that European writers almost invariably credit the name to Dietrich. The writer has been utterly unable to find the exsiccatæ anywhere in this country, and hence is unable to say what is the real state of affairs. Except for Dietrich's own citation and a reference in Lindau and Sydow's Thesaurus Litteraturae Mycologicae no mention of the exsiccatæ has been found. Evidently there were not many copies issued. Arthur (1907) cites the name as *Cronartium ribicola* Fischer von Waldheim in Rabenhorst's Fungi Europaei Exsiccatae, No. 1595, this evidently being the first description published since Dietrich's time. But Klebahn (1904*a*) distinctly states that Dietrich named and described this fungus in 1855. In either case the name is the same. In 1887 Klebahn separated *Peridermium strobi* from *P. pini* and named and described it. Rostrup in 1890 apparently named it *P. klebahni*. The status of the name of this stage is immaterial, since the name of the Cronartium state is oldest and holds good for the species in any case. The name *Cronartium ribicola* has been used for both stages of the fungus in this bulletin, since *Peridermium strobi* is a synonym only.

THE COMMON NAMES.

Cronartium ribicola and the disease which it causes have received a number of common or vernacular names which are more or less appropriate. The rusty appearance of the masses of spores has led to the terms "currant rust" and "Weymouth pine rust," the white pine being quite generally known in European countries by the name Weymouth pine, from Lord Weymouth, who first brought it into prominent notice in Europe. Any plant disease which results in a brown or reddish appearance of the affected leaves is likely to be called a "rust" popularly, no matter whether caused by a fungus, an insect, or insufficient or improper food and water supply. A name is needed which will not lead to such a confusion of totally different diseases. The Germans are usually very apt in making common names, and their names for the two stages of this fungus are especially applicable and appropriate. The rust on the currant leaves is known as "Filzrost" (felt rust) from the coarse hair-like outgrowths of the teleutospore stage, while the stage on the white pine is called "Blasenrost" (blister rust). Both names refer to the appearance of the fungus and are sufficiently distinctive to avoid confusion even in the popular mind.

DESCRIPTION OF CRONARTIUM RIBICOLA.

Arthur's description of the fungus *Cronartium ribicola* is probably the most complete yet given, and it is used herein with certain additions by the writer on points which have not previously been mentioned.[a]

Pycnidia caulicolous, scattered, honey yellow, forming minute, bladdery swellings exuding a sweet fluid. *Pycnospores hyaline, ovoid to elliptical, 1.9–4.7 μ.*

I. Aecidia caulicolous, *causing fusiform swellings of the stem or branches in most cases,* rounded to elongate; peridium inflated, rupturing at sides, thick, membranous, cells isodiametric, smooth or nearly so on outer surface, verrucose on inner surface; æcidiospores ellipsoid *to ovoid,* 18–20 by 22–23 μ; wall colorless, coarsely verrucose except on elongate smooth spot, 2–2.5 μ thick, on smooth spot 3–3.5 μ thick.

On Pinus strobus in Germany, Austria, Russia, Finland, Siberia, Sweden, Norway, Denmark, France, England, Belgium, Netherlands, Italy, and Switzerland. Introduced into the northeastern United States and Indiana, Ohio, and Ontario, Canada, in 1909.

On Pinus cembra in Russia and Switzerland.

On Pinus lambertiana in Germany.

On Pinus monticola in Germany and England.

On Pinus excelsa in Denmark.

II. Uredinia hypophyllous, thickly scattered in orbicular groups 1–5 mm. across, round, pustular, small, 0.1–0.3 mm. across, dehiscent by a central opening, at first bright yellow; peridia delicate, inner walls thicker than outer walls; uredospores ellipsoid to obovate, 14–22 by 19–3.5 μ, wall colorless, medium thick, 2–3 μ, sparsely and sharply echinulate.

III. Teleutal columns hypophyllous, cylindrical, 125–150 μ thick, up to 2 mm. long, curved, bright orange yellow, becoming brownish; teleutospores oblong or cylindrical, 8–12 by 30–60 μ, rounded or obtuse at both ends; wall nearly colorless, smooth, rather thick, 2–3 μ.

On Ribes aciculare, alpinum, americanum, aureum, aureum var. *leiobotrys, aureum* var. *palmatum, bracteosum, cynosbati, divaricatum, gordonianum, gracile, grossularia, grossularia* var. *arboreum, heterophyllum, intermedium, macrobotrys, menziesii, multiflorum, nigrum, nigrum* var. *aconitifolium, nigram* var. *crispum, nigrum* var. *laciniatum, orientale, oxyacanthoides, parvifolia, petraeum, prostratum, rotundifolium, rubrum, sanguineum, saxatile, setosum, and triste in Europe.*

On Ribes rubrum at Sapporo, Japan, and on Saghalin Island.

On Ribes longiflorum Nutt. in Kansas.

On Ribes rubrum, R. nigrum, R. aureum, R. grossularia, and R. irriguum in New York.

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[a] The italicized portions, with the exception of the names of hosts, are supplied by the writer.

FIELD CHARACTERS OF THE BLISTER RUST ON PINUS STROBUS.

White-pine trees affected with the blister rust have been seen by the writer which were 3, 4, 5, 6, or 7 and 10 years old. Many that have been seen were diseased on the second year's wood, while some have had the third year's growth affected. In some instances the disease has started at the upper end of the second year's growth and then extended into the third year's growth (Pl. I, *A*). In a few cases it has started in the main stem at the upper end of a year's growth and then spread into the bases of the branches at that point, causing the characteristic tapering swelling in the branches as well as in the stem (fig. 4).

The affected trees are peculiarly stunted in appearance, the tops in many cases having a bunchy growth so characteristic that they can easily be picked out from their healthy fellows by this character alone (Pl. II, fig. 1). The new growth of the last season is usually shorter than in healthy trees (Pl. II, fig. 2), and the new needles are apt to be somewhat yellowish in color. The normal stem is nearly uniform in size throughout each year's growth, while the wood of each year varies in diameter from that of other years. Trees affected by *Cronartium ribicola* usually have the stem swollen at one end of a year's growth. The swelling usually is in the shape of an elongated cone, rising quite abruptly to its maximum diameter and then tapering gradually down to the normal stem diameter (fig. 3; Pl. I, fig. 1).

In some cases the entire length of the year's growth is swollen irregularly and has a peculiar obese appearance (fig. 3). Scattered along this swollen area are a number of wart-like bunches, usually situated at old leaf scars.

The swellings on the stems and branches are usually located on wood which is at least three years old and has no needles, so they are easily detected. Where the disease has been present for a number of years the bark becomes irregularly cracked and fissured and abnormally thickened (Pl. II, fig. 1). The swelling in all cases seems to be caused by a decided thickening of the inner bark and bast tissues, resulting later in an increased production of corky tissue, the wood being very slightly, if at all, affected.

The fungus is capable of living indefinitely in the bark as long as the host tree remains alive. Fortunately, in far the larger number of cases the host succumbs in one or two years and the parasite being unable to live on dead material dies also. In such cases the bark becomes loosened around the stem, dies, and thus the fungus girdles the tree or branch and causes the death of the parts above. Sometimes the tree is girdled without perceptible swelling taking place, but this is not common (fig. 5).

One or more years after infection occurs, the infected stem or branch begins to show swelling, as just described. The swelling develops quite rapidly, probably within one or two months after starting. When it has become noticeable, small, more or less transparent, spots form. These develop into minute, blister-like bunches, surrounded at the base by a translucent spot, through which the yellow endochrome of the developing æcidial stage shows. A little later the blisters break open and exude tiny drops of a sweet, yellowish, sticky fluid. Examination with the microscope shows this fluid to be filled with myriads of tiny hyaline spore bodies (fig. 3). These may develop at any time from early spring to late autumn. Later, after a period of time of uncertain length (known in one instance to be about a year), the peridermium or æcidial spores are formed in pustules scattered over the swollen part. These pustules are rounded to elongate in outline, one-eighth to one-half inch by one-eighth to one-fourth inch. At first the bark breaks open, and a rounded mass of an orange color pushes through the fissure. This attains a height of one-eighth to one-fourth of an inch and breaks open irregularly, allowing the powdery contents to escape (Pl. I, fig. 1; Pl. II, fig. 2). After the spores are given off, a delicate whitish membrane is left standing upright around the edges of the fissure and projecting somewhat from it. Still later this also disappears, and one finds only an empty depression in the bark with more or less rounded outlines and with some whitish masses of material in the rough bottom, which, upon examination, prove to be masses of spores. These empty fissures are so characteristic that they may be easily recognized at once, even by the unaided eye. The yellow pustules, either before opening or after, are also very characteristic, and are likely to be found between the last of April and the middle of June. The whitish membrane may be found at any time from June 1 to late autumn; the empty fissures where the spores were earlier produced may be found at any time after June 1. Many times trees

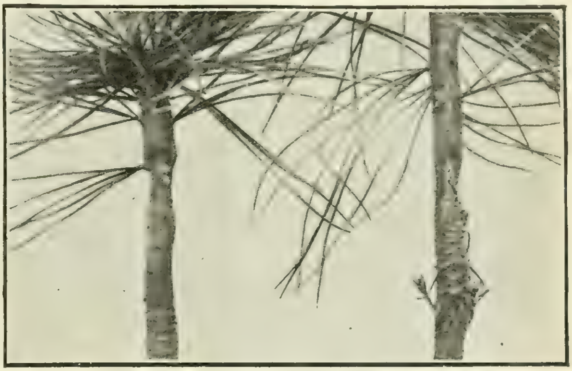

FIG. 5.—Two young trees of *Pinus strobus* with constrictions caused by *Cronartium ribicola*.

are found which have the swollen stem, but no spores or traces of pustules. These can usually be distinguished from trees affected by any other form of injury. An injury to the bark usually results in the formation of a swelling on the edges of the wound, but this can easily be distinguished from the hypertrophied condition brought about by *Cronartium ribicola.*

SOURCE OF DISEASED STOCK FOUND IN AMERICA.

Without a single exception, in 1909 diseased lots of white pine were traced to a common origin, i. e., the nurseries of J. Heins Söhne, at Halstenbek (Schleswig-Holstein), Germany. In a recent article Von Reitzenstein (1909) makes the statement that this disease is not present at Halstenbek, although admitting that it has been so serious that it caused discrimination against stock grown there. We are credibly informed that the State of Hesse-Darmstadt has officially forbidden the use in the State and communal forests of white pine raised by J. Heins Söhne at Halstenbek; also that this firm denies ever having had the disease.

Our investigations have shown not only that these nurseries have had this disease, but that it occurred there in the years 1908, 1907, 1906, 1905, and 1903. Importations inspected by members of this office made in the spring of the years succeeding these dates have had diseased trees. The disease (usually with fruiting bodies of the fungus) has been found upon trees 10, 7, 6, 5, 4, and 3 years of age which came from this nursery. The firm mentioned has shipped diseased stock to 226 out of the 230 known localities where such stock has been received in North America.[a]

A very peculiar feature was the great uniformity with which the disease occurred in all the shipments from this firm during 1909. Practically every lot of trees which were 3 years old was found to have some of the disease, in many cases the sporophores being found upon the dead and dying trees as well as upon trees which would certainly live one or more years longer. The proportion of diseased trees seems to be very uniform in all the lots of 3-year-old ones examined by the writer. Usually infection with a fungous disease occurs irregularly. The uniformity of infection in this case argues for the uniform presence of Ribes near a considerable portion of the nursery or a deliberate segregation of such stock for shipment to this country.

As already stated, lots of diseased white-pine trees were received in 1910 from the following firms in France: Levavasseur & Fils,

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[a] Moreover, stock has been received from this firm in the spring of 1911, which when unpacked, bore fruiting bodies of the blister rust.

Ussy; Barbier & Co., Orleans; and E. T. Dickinson, Chatenay. It is still uncertain whether these firms raised the diseased trees themselves or not.

THE BLISTER-RUST SITUATION IN AMERICA.

IMPORTATIONS OF SUSPECTED STOCK.

On June 5, 1909, the writer was asked to examine some young white-pine trees, which had been imported from Germany shortly before, for the purpose of determining whether they bore fruiting bodies of *Cronartium ribicola.* The trees had died after being set out in the field and such fruiting bodies as had been present, if any, had been washed off by heavy rains, so that the writer at the time was unable to decide as to the presence of the fungus. The spring before, a large lot of 2-year-old trees had been imported from the same nursery and had been examined at that time for the fungus, with absolutely no indications of it having been found. These were in June, 1909, again examined by the writer and the fungus was found to be present upon a considerable number of the then 3-year-old trees. Exactly the same thing has happened with 2-year-old trees imported in 1909, which have developed the disease in 1910. Further investigation showed that the disease had been imported upon trees in the spring of 1909, as well as upon the above-mentioned ones of the same age which were imported a year before. Suspicion thus rested upon all the trees imported in 1909 from the same nursery, and it was found that such trees had gone to the States of New York, Vermont, New Hampshire, Massachusetts, Connecticut, Pennsylvania, Minnesota, and to Ontario, Canada.

In 1910 the New York horticultural inspectors discovered diseased white-pine stock received from Barbier & Co., Orleans, France. The horticultural inspectors of Ohio also discovered diseased stock in that State which came from the other two French firms already named on this and the preceding page.

THE BLISTER RUST IN NEW YORK.

The situation in New York was attacked with the greatest vigor as soon as the presence of the disease was known. Mr. C. R. Pettis at once brought the matter to the attention of Mr. J. S. Whipple, Forest, Fish, and Game Commissioner, and arrangements were immediately made for a meeting of the representatives of the forestry interests involved, or likely ultimately to become involved, to be held in the city of New York. At this meeting those then involved pledged united action against the disease, each State Forester agreeing to begin at once the removal of Ribes from the vicinity of the plantations of diseased trees in his State. In New York this work was carried on by the Forest, Fish, and Game Commission in cooperation with the State Department of Agriculture. Letters were sent to the persons having lots of the trees from J. Heins Söhne, telling them of the discovery of the disease and asking the owners to remove the Ribes within their plantations, as well as within 100 yards of their outer limits. While this resulted in considerable help, the inspectors usually had most of this work to do, but considering the difficult nature of the work the entire State was covered in a short time. That this was accomplished none too quickly was shown by the discovery of a single case where the fungus had transferred from the imported pines to currants near by. The spores were still inclosed beneath the epidermis of the currant leaves, so that not one had yet been set free. Only uredospores were formed, which are unable to infect pines, so the disease was checked in the nick of time. This State, which has had more imported trees than any other, proposes to insure freedom from disease in the future by stopping the buying of foreign stock and by raising its entire supply. In 1910 all importations of white pines were again inspected and the diseased trees destroyed. The work this season showed that the Ribes are again sprouting up where they were removed in 1909. The safety zone was increased from 300 to 500 feet in width in 1910.

THE BLISTER RUST IN VERMONT.

The trees in Vermont, like those in New York, were obtained of J. Heins Söhne. What has been said of New York in regard to the action taken against the blister rust is also true of Vermont. The State Forester handled the entire matter with advice from the State Botanist as to procedure. Here the safety zone around the infected plantations was made 500 feet wide instead of 300. The Ribes were removed, and the affected pine trees destroyed in all the plantations of the diseased trees. No more imported trees will be distributed by the Vermont State Forester. In 1910 the plantations of imported trees were again inspected and the diseased trees destroyed.

THE BLISTER RUST IN NEW HAMPSHIRE.

No trees were supplied in New Hampshire by a State Forester and no plantations were made of imported stock except a few scattering ones made by people who imported their own supply. Most of these were inspected by the writer in 1909 and 1910.

THE BLISTER RUST IN MASSACHUSETTS.

In Massachusetts the imported trees, also from J. Heins Söhne, were set out on State lands and were not distributed to private parties to set upon private lands, as was the case in New York, Connecticut, and Vermont. The problem was accordingly much simpler.

The State Forester ordered the removal of Ribes from the plantations, and his order was carried out in good season. The native *Ribes prostratum* was plentiful upon some of the lots and entailed much thorough and painstaking labor for its complete removal. Diseased pine trees were found in immediate proximity to the Ribes, but fortunately none of the latter were found infected when they were removed.

THE BLISTER RUST IN CONNECTICUT.

In Connecticut the imported trees were distributed to private parties throughout the State. The trees were obtained from J. Heins Söhne. Most of the inspection in 1909 in this State was done by the writer and Dr. A. H. Graves, Special Agent of the Bureau of Plant Industry, owing to the absence of the State Botanist in Japan until late in the season and the resignation of the State Forester, who accepted a similar position in Vermont shortly before. A large part of the State was covered and the State authorities agreed to complete the work in 1910. Several large private importations were also inspected in this State by the writer. Arrangements have been made to obtain the future supply of trees in this country.

THE BLISTER RUST IN PENNSYLVANIA.

Several privately owned plantations of white-pine trees in Pennsylvania imported from J. Heins Söhne were inspected by Prof. J. F. Collins, Special Agent of the Bureau of Plant Industry. These have had the diseased trees and Ribes removed and destroyed. Last spring (1910) a very large lot was discovered by the writer and has been inspected by the State Nursery Inspector.

THE BLISTER RUST IN MINNESOTA.

A single lot of white-pine trees from J. Heins Söhne is known to have gone to Minnesota. The State authorities inspected these trees, but no diseased ones were found.

THE BLISTER RUST IN OHIO.

Diseased trees have been found by the State Horticultural Inspector in Ohio in two different places. These were received from the two French firms of Levavasseur & Fils, Ussy, and E. T. Dickinson, Chatenay. It is not known whether they were raised by these firms.

THE BLISTER RUST IN INDIANA.

A diseased lot of white pines has been reported by the Indiana State Entomologist as having been found in that State recently.

THE BLISTER RUST IN ONTARIO, CANADA.

Some of the trees from J. Heins Söhne went to Ontario. The Dominion authorities have agreed not to import further and Canada has prohibited the importation of white pine affected with this disease.

There are, doubtless, other scattering lots of diseased trees which have come into the country, especially to ornamental nurserymen. It is earnestly hoped that the owners will promptly notify the Office of Investigations in Forest Pathology of the Bureau of Plant Industry about them, so that they may be inspected and the presence or absence of the disease determined before the fungus has obtained a foothold on native white-pine trees in the vicinity.

METHODS OF COMBATING THE BLISTER RUST.

PREVENTIVE MEASURES AVAILABLE IN AMERICA.

American nurserymen have one effective method of combating the blister rust, i. e., to stop importing European stock of any of the five-leaved species of pine. A nurseryman who imports no five-leaved pine and who allows no imported Ribes to grow near his nurseries need have no fear of the blister rust. Those nurserymen who import or handle imported stock of Ribes must maintain a rigid and carefully planned and executed inspection of such stock during its first season in their grounds and keep such stock segregated from other Ribes and white-pine stock or they may find themselves unexpectedly faced with this serious trouble. In places where the disease is already present, the only course is to remove the least valuable of the two hosts and destroy all diseased plants of the remaining host. Two or three inspections in July and August at intervals of ten days to two weeks should make sure of all infected Ribes if the diseased and suspected ones are each time destroyed when found. In an infested lot of pines, inspections made during the month of May for several consecutive years should be sufficient, provided all suspicious trees are at once burned. In the case of an infected plantation or nursery of pines all wild and cultivated currants and gooseberries should be promptly removed to a distance of 500 feet from the edge of the area containing the pines. The pines should be very carefully inspected and all trees which show the least signs of this disease should be burned at once. Another inspection the following spring should result in the removal of those infected trees which were not detected the first time. If none be found in the second inspection it is probable that all the diseased trees were found in the first inspection. Owing to the indefinite period of incubation of the fungus it is unlikely that a single inspection will result in the removal of all of the infected trees.

All white-pine trees imported before they are 3 years old should be inspected when they reach that age, as the disease does not usually become visible on younger trees. A few writers have mentioned it as occurring upon 2-year-old trees (Spieckermann, 1905; Pechon, 1907; Rostrup, 1902), but this seems to be exceptional and is not known to occur in this country. It is advisable that imported trees be held in nursery rows for at least one year in order to determine beyond a doubt whether the disease is present.

Any person buying young five-leaved pine trees should require the seller to guarantee the stock to be free from this disease, or, better still, to have been raised in America, since foreign stock is liable to be diseased.[a] Foreign seed will not carry this fungus, and is perfectly safe so far as the blister rust is concerned.

The Office of Investigations in Forest Pathology will teach inspectors the characters of the disease and so far as possible will make inspections where there are no State inspectors or where local inspectors are unable to do so. Specimens of trees or of Ribes leaves will be promptly examined and the results reported, with suitable recommendations for treatment. It is recommended that shipments of imported trees be reported to the office mentioned, together with the name of the nursery or firm from which they were obtained. This will enable it to take prompt action in notifying owners of new developments in regard to treatment, etc.

RECOMMENDATIONS OF EUROPEAN WRITERS.

Eriksson (1896 *a*) made the following recommendations for combating this disease in Sweden: Inspect plantations and nurseries in April and May; cut out diseased branches in old trees and burn them; cover infected places with tar or tar and lime to prevent spermogonia and aecidiospores being set free; remove white pines from vicinity of currants; collect and burn rusted currant leaves in late spring; raise young trees from seed of healthy trees.

Schøyen (1897, 1901), in Norway, recommends removing diseased Ribes bushes from white pines.

Hollrung (1898) cites recommendations issued by the Prussian ministry of agriculture, domains, and forests, as follows: Destroy affected seedlings; in new plantings place white pine at least 50 meters from Ribes, and plant another kind of tree between the two.

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[a] Persons insisting upon importing white-pine stock will endanger themselves and the rest of the country somewhat, even after they take all precautions in inspecting such foreign stock and eradicating diseased trees.

Weiss (1899, 1900), in Bavaria, admonishes owners of nurseries to see that only healthy trees are sold, also that only trees more than 4 or 5 years old be bought, since the disease shows before this time.

Hess (1900), in Germany, says that buyers should require proof of the good health of stock before buying and planting out; they should also remove and burn diseased trees and remove Ribes for a distance of at least 50 meters.

Nypels (1900), in Belgium, says that Ribes in the vicinity of a diseased nursery or plantation of pine should be destroyed.

Marchal (1901), also in Belgium, recommends burning diseased trees or parts and the removal of Ribes to a distance of 30 meters.

Von Tubeuf (1905 *b*, 1905 *a*), in Germany, mentions burning of diseased trees and bushes, the separation of the two hosts, the picking off of diseased Ribes leaves, and the raising of stock from seed in order to be free from this disease.

Pechon (1907), in Belgium, recommends planting *Pinus strobus* in mixture with other species, obtaining stock from a nursery known to be free from the disease or raising it for one's self, burning affected trees, and separating Ribes from pines. He also says painting with tar and other similar methods are not efficient.

Schelle (1909) recommends spraying with a solution of 2 per cent of copper sulphate and 2 per cent of lime to prevent the distribution of spores.

In considering these recommendations of European writers we must remember that the aim in Europe is *not* complete eradication, since the fungus is so prevalent and universally distributed that this is plainly impossible. The object is simply to keep the fungus down to such a point that it will do little damage. Here in America we have every opportunity thoroughly to eradicate the fungus which is already in the country and to be sure that no more is allowed to come into the country. In the cases of a locality in Kansas and at Geneva, N. Y., the fungus has already been eradicated successfully. The life history of the fungus is such that there is a very good chance to do this before it becomes established.

EFFECT OF NEW HOSTS AND CLIMATE UPON THE VIRULENCE OF FUNGOUS PLANT DISEASES.

It is a well-known fact that a fungous disease of plants when introduced into a favorable new climate or attacking new hosts is apt to become more virulent and cause greater damage and more complete destruction than when in its native climate or on native hosts. It is also true that such diseases do not run out after a few years and disappear. A new fungous disease established in a new country with a favorable climate is a permanent factor and must be reckoned with ever after. While we fortunately have rather few instances of such diseases, those that we do have corroborate these statements. The following cases are well known and serve to bring out these two points.

One of the most disastrous instances of the introduction of a parasitic fungous disease into new countries was that of the grape mildew (*Uncinula necator* (Schw.) Burr.).[a] This fungus was native in America on wild species of vines. In 1845 it was first discovered in Europe in England. The next year it spread around the original neighborhood in hothouses. In 1847 it was found in one locality in France and the next year occurred in several localities there and also in Belgium. In 1850 it devastated the vineyards around Paris and was found in Spain and Italy. In 1851 it was general in the French vineyards and those of the Mediterranean basin; it was also newly reported from Hungary, Greece, Switzerland, Syria, Asia Minor, and Algeria. In 1852 it broke out in Madeira and in 1866–67 it appeared in Australia. Except as mentioned the damage was not great, but in 1852, 1853, and 1854 the yield of the French vineyards was reduced to a tenth or twentieth of the normal crop. The population of certain districts emigrated. After 1855 the damage decreased. The disease is still present every year and causes great losses; methods of combating it have, however, been found, so that it is greatly checked. But we do not have to go back of recent years for instances of the introduction of fungous diseases into new regions. As recently as 1900 the American gooseberry mildew[b] (*Sphaerotheca mors-uvae* (Schw.) B. and C.) was first discovered in Europe in Ireland; in 1901 it was present in Sweden and Russia; in 1902 in Denmark; in 1903 in Germany; in 1904 in Finland and Norway; in 1905 in Austria; in 1906 in England and at Tomsk, Siberia; while in 1907 it was reported from thirty-three Governments in Russia.

The best known instance of great damage resulting from the introduction of a parasitic fungus into new regions is possibly that of the potato blight caused by *Phytophthora infestans* De Bary. This was apparently native in South America,[a] where it occurs upon the cultivated potato as well as various wild species of the same genus. The early history of this disease is somewhat uncertain, but apparently it was responsible for serious trouble with potatoes in Germany as early as 1830. In 1836 it broke out in the Rhine plain, between Coblentz and Cologne; after this time it gradually spread to Hesse, the Palatinate, and central Germany. In 1842 it certainly was present in Germany and was also discovered in the same year in Belgium and Ireland. In 1845 it was found in England, Scotland, and France. It is said to have been found in the United States as early as 1840; occurred near Boston in 1842, near New York in 1843, and in 1844 was found in Canada and at numerous points in the United States. In 1845 it caused a very serious outbreak of disease in certain parts of Canada, Ireland, and the larger part of Europe. This outbreak continued with great intensity until 1850; in 1851 the intensity decreased. Since this time the disease has spread into practically all parts of the world where the potato is grown. It is present every year in those localities where it has occurred and if weather conditions are favorable serious outbreaks occur.

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[a] Viala, Pierre. Les Maladies de la Vigne, 1893, pp. 2–4.

Salmon, E. S. A Monograph of the Erysiphaceæ. Memoirs of the Torrey Botanical Club, vol. 9, 1900, pp. 99–105.

[b] Salmon, E. S. On The Present Aspect of the Epidemic of the Gooseberry-Mildew in Europe. Journal of the Royal Horticultural Society, vol. 29, 1905.

Elenkin, A. A. Zhurnal Bolyezni Rastenii, vol. 1, 1907, pp. 3–7.

Eriksson, J. The Gooseberry Mildew in Europe. Its Spread and Prevention. Zeitschrift für Pflanzenkrankheiten, vol. 16, 1906, pp. 83–90.

Herter, W. Die Ausbreitung der Stachelbeerpest, Sphaerotheca mors-uvae (Schweinitz) Berkeley in Europa im Jahre 1906. Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten, pt. 2, vol. 17, 1907, pp. 764–773.

Salmon, E. S. On the American Gooseberry Mildew and the Need for Legislation. Journal of the Royal Horticultural Society, vol. 31, 1906, pp. 128–137.

But the diseases mentioned are caused by fungi quite different from the white-pine blister rust. The following cases are those of rust fungi, but both are capable of living on a single host, and do not require two different ones, as does the white-pine blister rust.

The asparagus rust (*Puccinia asparagi* DC.) was introduced into this countryin 1896 from Europe;[b] within ten years it was spread over practically the entire country and had inflicted a great amount of damage. It is still with us and causes much damage every year.

The hollyhock rust [c] (*Puccinia malvacearum* Mont.) was native in Chile. In 1857 it was discovered in Australia. It was first discovered in Europe in 1869, in Spain; then in France in 1872; in England and southern Germany in 1873; in northern Germany and Italy in 1874; in Switzerland and on the Cape of Good Hope in 1875; in Austria and Hungary in 1876; in Greece in 1877; in Sweden in 1887, and in Finland in 1890. It apparently first entered this country in Massachusetts in 1886,[d] when it was first discovered here. It soon spread throughout the United States and has been present ever since.

Finally we may take *Cronartium ribicola* itself. This was endemic upon *Pinus cembra* in Russia and Siberia and possibly in the Alps.

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[a] Prunet, A. Le Mildiou de la Pomme de Terre. Revue de Viticulture, vol. 17, 1902, pp. 663–666.

[b] Halsted, B. D. The Asparagus Rust; Its Treatment and Natural Enemies. New Jersey Agricultural Experiment Station Bulletin 129, 1898, pp. 4–5.

[c] McAlpine, D. The Rusts of Australia, 1906, pp. 43–44.

[d] Dudley, William R. The Hollyhock Rust. New York (Cornell) Agricultural Experiment Station Bulletin 25, 1890, pp. 154–155.

It was first found in the Baltic provinces of Russia in 1855. In 1869-1875 it was epidemic in Finland on *Pinus strobus*. In 1871 it was found in Denmark, and in 1872 in northern Germany. It is now known practically throughout Europe. This distribution is probably the most striking and most rapid of any known instance among the heterœcious fungi. This has had both new climatic conditions and new hosts to increase its virulence in Europe. These factors, as well as others, would greatly favor its spread in America should it once become established here. There seems to be no reason to expect it to be less destructive than it has been in Europe and there is every reason to fear that it may be much more so. This is especially true of the West, where the rusts seem to find their most favorable climate. That this fear is held by foreign mycologists is shown by the following statement by Somerville (1909) of England: "But it is to be feared that the day is not far distant when it will gain a footing in North America, and if it spreads there as it has done in Europe the loss that will result through the destruction of one of America's most valuable lumber trees can only be described as appalling."

PRACTICAL SUGGESTIONS.

DANGER TO ALL FIVE-LEAVED PINES.

The white-pine blister rust is anomalous and almost unique among plant diseases. It originally attacked the stone pine (*Pinus cembra*), which is a native of Europe, the fungus itself being also endemic in Europe. About two hundred years ago the white pine (*Pinus strobus*) was introduced into Europe as one of the most promising of American conifers. It was widely disseminated in the various European countries and even extensively planted in the forests. About fifty years ago the blister rust of *Pinus cembra* was found attacking *P. strobus*. The disease has continued its attacks upon the new host with all its original severity, while upon the stone pine it causes relatively slight damage and does not seem to be spreading rapidly.

Pinus cembra and *P. strobus* are five-leaved species and are quite closely related to each other. The blister rust has been found upon *Pinus monticola* and *P. lambertiana*, which are five-leaved species and are even more closely related to *P. strobus* than is *P. cembra*. They are American species, occurring naturally in the Rocky Mountain region. What is probably the same blister rust has been noted in Denmark upon the Himalaya pine (*Pinus excelsa*), also a five-leaved pine (Rostrup, 1902). The fungus has had every chance to infect other pines in Europe which are not five-leaved, so that it seems to be fairly well proved that it attacks only the five-leaved ones, which belong to the group known as white pines. In the

United States the five-leaved pines occur naturally in the forests of the entire country except the section from Texas and Oklahoma eastward and north to the Ohio River, which is occupied by the southern yellow pines. Even here the white pine (*Pinus strobus*) extends in the Appalachians to northern Georgia and Alabama. Moreover. *Pinus excelsa* and *P. ayacahuite* are commonly planted in this section as ornamentals and their use is increasing. Wild and cultivated species of Ribes occur throughout the entire country, so that it would be merely a question of time for *Cronartium ribicola* to spread over the country if it once becomes established.

WHY THE DISEASE MAY BE EXPECTED TO BE WORSE IN AMERICA THAN IN EUROPE.

When a fungus is introduced into a favorable new climate or attacks new host species it is likely to become more virulent and to cause greater and more complete destruction than before. Such diseases do not run out. When a fungus is once established in a new region it is a permanent factor in the cultivation of its host plants ever after. The histories of the potato blight (*Phytophthora infestans* De Bary), the grape mildew (*Uncinula necator* (Schw.) Burr.), the asparagus rust (*Puccinia asparagi* DC.), the hollyhock rust (*Puccinia malvacearum* Mont.), and other parasitic fungi which have been carried from one continent to another, prove the truth of these statements.

In Europe *Pinus cembra* and *P. strobus* are quite generally distributed, but none of the other known pine host species of *Cronartium ribicola* are very generally distributed there. This practically limits the fungus to the two species *Pinus cembra* and *P. strobus* in Europe. The first is not usually seriously injured, while the latter, as well as the other American host pines, is very seriously injured. Here in America all the native species of five-leaved pines are liable to be attacked. This fungus is exterminating white pine, and is attacking *Pinus monticola* nearly as badly in England (Somerville, 1909). There are numerous other sections where white pine is very seriously injured. With the great variety of climatic conditions which obtain in various parts of America it will be surprising if the fungus does not find some section suited to its best development. We have every reason to expect this disease to be as bad as or worse than it is in Europe if it is allowed to become established here.

ESTIMATES OF POSSIBLE DAMAGE.

A very crude idea of the loss which this disease might inflict may be obtained as follows:

The census returns show that the total valuation of the forest products derived from the five-leaved pines, as far as they are separately obtained, for the year 1908 was about $65,000,000.[a] If only 1 per cent of the stand was affected, the loss would be $650,000 a year.

Estimates for the year 1909 show that the valuation of the white pine then standing was about $600,000,000,[b] while that of the sugar pine (*Pinus lambertiana*) was about $120,000,000. Taking a loss of 1 per cent (which is very conservative for this, as well as other fungous plant diseases), we have losses of $6,000,000 and $1,200,000, respectively. The smaller alone far outweighs the total valuation of all the five-leaved pine stock that has ever been imported into the country. While the losses would be expected to occur somewhat in older trees, the greater part would be in trees less than 25 years old. Should the situation become as aggravated as it now is in England (Somerville, 1909) the losses would far exceed 1 per cent on all sizes of trees.

Estimates of the extent of the nursery interests concerned with the five-leaved pines are not obtainable. In New England white pine is used in about 90 per cent of all the planting done. It has been estimated that about 200,000,000 [c] feet of lumber may be cut from the present plantations of New England between 1930 and 1950. The writer has collected such data as he could upon the extent of the planting movement in the Northeastern States with regard to the amount of white-pine stock utilized for planting. These data are necessarily fragmentary, being compiled from several different sources, but they much understate the facts rather than exaggerate them. It has been found that the States of New Hampshire, Vermont, New York, Pennsylvania, New Jersey, Connecticut, Rhode Island, and Massachusetts have planted an area of approximately 13,000 acres with this species. In the single year 1909 about 3,000 acres were planted in New York, Vermont, New Hampshire, Massachusetts, and Connecticut. These figures show that the planting movement has reached a really important volume. The setback from the white-pine rust is already perceptible, but it is temporary, being caused only by waiting for American nurserymen to rise to their opportunities and produce healthy stock at reasonable prices. One large company is already offering such stock at a very material reduction in prices from those which have previously been quoted. If the white-pine blister rust becomes a permanent factor in the cultivation of this species in America the planting movement will be seriously discouraged and greatly checked at the very time it bids fair to accomplish results commensurate with our needs.

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[a] Forest Products, Bulletin 10, Bureau of the Census, Dept. of Commerce and Labor, 1909, pp. 1–137.

[b] Kellogg, R. S. Circular 166, Forest Service, U. S. Dept. of Agriculture, 1909, pp. 8, 19.

[c] Peck, A. S. Report of the National Conservation Commission, vol. 2, 1909, pp. 668–686.

ACTUAL COST OF IMPORTED WHITE-PINE STOCK.

The original cost of white-pine planting stock is undoubtedly less in European countries than in America. But a number of other factors must be considered when the actual cost of imported European stock is determined. The following table gives a comparative statement of the various items entering into the final cost of such stock, taking 3-year-old trees as a basis upon which to work.

Total cost of imported white-pine stock.

Cost in European nurseries	$1.50 to $2.50 per 1,000.
Cost in American nurseries	$5 and upward per 1,000.
Cost of boxes for shipping in Europe, about	50 cents per 1,000.
Cost of baskets for shipping in Europe, about	35 cents per 1,000.
Cost of boxes for shipping in America	15 to 25 cents per 1,000.
Cost of freight from Europe to America	40 to 50 cents per 1,000.

In analyzing this table it must be stated that the cost of packages for ocean shipments is high, owing to the greater strength and solidity necessary to undergo the long shipment. The freight charges by steamer are entirely extra, as the charges from the port of entry will about balance the charges on domestic stock from nurseryman to planter.

Besides the above monetary considerations one must take into account the following factors, which should have much weight in deciding whether or not imported stock is to be used:

(1) The relative excellence of the two kinds of stock. While it is generally true that imported stock is as good or better than most American stock, it should not be better, as it has been shown that just as large and good stock can easily be raised even in the Adirondacks (Pettis, 1910), where the growing season is very short. The writer knows from personal observation that the finest stock can be raised where the growing season is longer.

(2) The risk of the stock being damaged by the ocean voyage. This is by no means an insignificant danger, as is shown by the condition of various shipments every spring. Many European nurserymen do not pack coniferous stock in the best manner; only a few, in fact, being known who send shipments with uniform success. During the spring of 1910 several large shipments were received so badly molded and dried out that they were nearly worthless. Beside the actual damage must be considered the disappointment of the planter, as it is impossible to secure a second lot of stock in time to use it that season.

(3) The importation of insect and fungous pests, which may soon cause far more loss than the entire value of the imported stock. Moreover, they are almost certain to cause the owner greater loss than his neighbors, since they usually are worse in the vicinity where they first break loose. American nurserymen are realizing that they must grow coniferous stock in larger quantities and at moderate prices. There is quite a universal movement in enlarging the output of these species throughout the country, several firms already turning them out by the million, one having also reduced its prices to such a point that they compare very favorably with European prices.

WHY PORT INSPECTION IS INEFFICIENT.

Cronartium ribicola vegetates in the bark tissues of pine for a number of months before any external signs of its presence are visible. This period of incubation is of uncertain length, but apparently varies from about one year to several years. During this time no inspection, however thorough, can detect the disease. A very good example of this is afforded in connection with certain trees imported in 1908 when two years old which the writer carefully examined in 1908 for this disease without finding the slightest signs of it. In 1909 1 per cent were affected. The same thing has happened in others imported in 1909 when 2 years old. They now have the disease. Dock inspection can not detect affected trees except such as already have developed swellings or fruiting bodies. This is true of any single inspection which can be made. Repeated inspections are absolutely necessary in order to make sure that imported stock is free from this disease. Such repeated inspections soon cost more than the value of the seedlings.

WHY NO NURSERY CAN BE GIVEN A CLEAN BILL OF HEALTH.

The giving of a clean bill of health to a nursery has the same difficulties as inspection. An inspecting pathologist would have to know intimately the entire neighborhood surrounding the nursery; he would have to watch the nursery for at least two years, and in most cases longer, in order to be able to certify that this disease was not present. A single brief trip to Europe by an American pathologist could not possibly give conclusive evidence regarding a single European nursery, to say nothing of dozens. The proposition would involve the residence of a pathologist in Europe who would spend most of his time in examining nurseries. Even this could not be conclusive unless the entire life history of the imported seedlings was known to this man.

PREVENTION ALWAYS EASIER AND CHEAPER THAN CURE.

The essential feature of all plant pathological work which has to do with combating disease is prevention rather than cure. This is necessarily so, since the nature of plants renders curative measures of very doubtful efficacy as a rule. If the disease can be prevented the work is much more successful and satisfactory than when endeavors are made to stop a serious outbreak. This is preeminently the case with America and the white-pine blister rust. Comparatively small effort will keep it out, while no effort likely ever to be exerted will stop it after it once becomes established here. The sooner the situation is taken in hand the cheaper it can be done. The situation in Europe is steadily growing worse so far as we are able to judge, and this would be the case in America should this disease obtain a secure foothold. The disease has been eradicated once in America, and it can be done again if the recommendations herein made are carried out.

THE WORK OF ERADICATION MUST BE DONE BY THE STATES.

There are no Federal laws in this country which apply to plant diseases. Hence the United States Department of Agriculture is without power to prohibit the importation of white-pine stock, even if known to be diseased. This places all responsibility on the various State organizations, as most of the States have laws of some sort for the regulation of serious plant diseases. Those which have none must in self-defense pass them at once. The Office of Investigations in Forest Pathology of the Bureau of Plant Industry is ready to do all in its power, and to that end will instruct inspectors, make examination of material sent to it, and advise as to the best methods of combating the disease in specific instances. It has a limited supply of colored charts of this fungus (Von Tubeuf, 1905 *c*) which will be sent to applicants.

CAUTION TO GENERAL NURSERYMEN.

Nurserymen who handle and grow any of the species of currants and gooseberries will do well to keep *Cronartium ribicola* in mind at all times. Its three appearances on Ribes in this country are utterly inexplicable, and two of them may have been the result of importing new stock and varieties. Notwithstanding that it is supposed to attack only the leaf blades of Ribes, there is the possibility of its infecting buds or young wood and thus being carried on dormant bushes or cuttings. There is constant danger when Ribes and *Pinus strobus* or any other five-leaved pine is imported from Europe, and the general nurseryman will but follow the dictates of simple prudence if he keeps Ribes well separated in his grounds from the five-leaved pines of any species and if he inspects his currants and gooseberries once in a while every summer for the fungus. Specimens of diseased leaves should be sent to the State agricultural experiment station or to the Office of Investigations in Forest Pathology of the Bureau of Plant Industry for identification of the fungus infesting them.

REMOVAL OF RIBES.

The cultivated Ribes give little or no trouble in removal, as they are all species which grow in definite clumps and can be uprooted quite easily. The wild species, however, vary much in their characters; most of them grow in more or less definite clumps, several feet in height, so that they are quite easily located by the inspector. The spiny species, such as *Ribes cynosbati*, are very difficult to handle and the person removing them should have a heavy pair of leather gloves. *Ribes prostratum*, the skunk currant, offers other difficulties; it grows in swampy locations and spreads by underground stems which creep under the dead leaves and débris and show only their tips, which rise only to a height of 6 to 18 inches. It requires close inspection to detect this species even where it is quite plentiful. It usually does not grow in heavy woods but in rather open forest or open swampy places. It requires the utmost care to succeed in removing every piece of the spreading root stocks. A small bit left will suffice to renew the plant; hence it is imperative that it be entirely removed. In the summer of 1910 it has been found that new plants occupy the ground from which Ribes were removed the previous season. The creeping species may be expected in nearly all parts of New England and in elevated parts of New York, the Lake States, and southward in the Appalachians to North Carolina. The upright species may be found almost anywhere throughout the country where shrubbery of any kind is found growing wild.

THE PRESENT SYSTEM OF HANDLING IMPORTATIONS UNRELIABLE.

The present system of handling imported stock for insect inspection may be briefly outlined as follows: Customs house officers send to the Entomologist of the United States Department of Agriculture a daily report of importations of nursery stock, covering the following items, as well as others: (1) Consignor, (2) consignee, (3) kind of stock, and (4) number of packages. Each of these statements may be either indefinite or erroneous. (1) The name of a European agent may be given as the consignor, whereas the information wanted is the name of the nursery where the stock originated. (2) The name given as the consignee is very often that of an agent or broker, and does not show the destination of the stock. (3) The description of the stock may be so worded that practically no information is given. (4) The specification as to the number of packages may be indefinite as to the number of trees. This should be given in round numbers at least.

Even with these statements in hand it is impossible in many cases to tell what shipments contain white pine or Ribes, from what nursery they come, or to whom and where they are going, all of which information is necessary in order to decide whether inspection is needed and to notify the proper inspection authorities when necessary.

Besides the notice from the customs house, the railroads send in notices of lots forwarded by them. Upon receipt of these statements the Entomologist of the Department of Agriculture informs the inspectors of each State about the stock needing inspection which is on its way to that State. This procedure works fairly well for insect pests, but could be much improved. For the white-pine blister rust it is very defective and results in much useless expenditure of money and time in tracing uncertain lots of stock. The past spring the Office of Investigations in Forest Pathology sent notices to the State inspectors concerning all suspicious lots of trees, but we are far from sure that all or even the greater part of the importations were known. A very radical change is needed to make the service as efficient as it should be.

At present Federal pathologists have absolutely no power with regard to diseased stock in any State; hence State officials must handle the inspection and take such measures as their laws provide. The States vary much in the efficiency of their inspection laws and in the execution of those laws, the protection afforded ranging from practically none to nearly perfect. Even in the best protected States it is not uncommon to find lots of stock which have gotten into the State without the inspector having been informed. In the other States it is very common for such lots to gain entry entirely unknown to the proper authorities. Besides all this the State laws apply only to stock raised within the State or shipped from outside the State to some point within and then unpacked and planted out. That is, any amount of stock may be imported and shipped again to other States without being required to pass any inspection at all. In nearly all States the imported stock may even be repacked into smaller lots before being reshipped. The next State receiving such stock receives it under the assumption that it was raised in the former State, and it is inspected or not, as the laws of the latter and its inspection service may determine.

As previously stated in this bulletin, it is quite a general custom among nurserymen handling ornamental stock to import their supply of 1-year-old conifers. The cost is small and this procedure saves annoyance and the bother of handling seed beds of their own. It is also not uncommon for these nurserymen to buy older stock and fill their orders with it. The ornamental trade usually calls for small lots of each species used, thus giving a maximum distribution to diseased trees. In this way a lot of 50,000 trees might very easily be sent to hundreds of different places throughout the country. In these cases it is impossible to trace all such trees to their final destination, and it is exceedingly difficult to learn of the importations so that they can be inspected before being distributed to the planters.

Besides the ornamental nurseryman, an increasingly large number of private growers import directly for their own use in lots of five thousand to several hundred thousand. These trees are especially hard to locate.

A third class of importers are the brokers who handle only large lots; these import all their stock and sell it to nurserymen or to private individuals in lots ranging from one thousand to several hundred thousand. The brokers' transactions in many cases do not come under the State laws, and considerable of their stock is never inspected. For instance, a lot of trees is received by a New York broker at the Hoboken wharves; he immediately sends some of it to a Middle Atlantic State. That stock is not inspected by the New York inspectors, as its destination is another State, and it is not unpacked in New York. When received at its destination the shipment is either planted out in a nursery or is again split up and forwarded to still other localities, partly in other States, where it finally is planted out. In each shipment of the lot from one State to another no inspection is made by the State from which the shipment is made, and if the laws or inspections are defective for any reason in the State receiving the shipment the diseased trees may pass the entire gamut without ever passing under an inspector's eye. Many such cases occur every spring.

LEGISLATION AGAINST PLANT DISEASES.

Owing to the impracticability of inspection to detect the blister rust, some other method of handling it is necessary. The difficulties in giving foreign nurseries a clean bill of health seem to preclude this procedure. Whether foreign authorities can be induced to take up the supervision of their nurseries and give certificates which are reliable is very questionable and at the best will take much time. Most of the foreign inspections for insects are known to be superficial and inefficient at present. The only measure left available seems to be the prohibition of the importation of white pine and Ribes, at least temporarily and from certain sections.

Such prohibition of the importation of special plants because of dangerous fungous diseases is by no means a rarity in other countries and is in full operation for diseases of animals in this country. England[a] has faced the same sort of exigency in the case of the American gooseberry mildew and has recently prohibited the importation of gooseberry and currant plants. This action probably was taken too late, as the disease had become well established already. Similar action against the same fungous disease has been taken by Ireland,[b] Sweden,[c] and Finland,[d] and such action is more than likely to be taken by a number of other European countries which have discovered the fungus present within their boundaries.

The white-pine blister rust is not the only serious foreign fungous disease which threatens shortly to become established in America. The wart disease of the potato caused by *Chrysophlyctis endobiotica* Schilbersky is prevalent in a number of European countries and has caused much alarm there because of its destructive attacks and its ability to survive for a number of years in the soil. This disease is already present in North America, having been recently discovered in Newfoundland. Seed potatoes have recently been shipped from Newfoundland to this country, but so far as known the disease is not yet present here. It is already a proscribed disease in Canada, Ireland, Great Britain, Sweden, and the Transvaal.[e]

Some sort of prohibition of the importation of plants is in force in Germany,[f] Crete,[g] Portugal,[h] Turkey,[i] Argentine Republic,[j] Tunis,[k] Cape Colony,[l] Transvaal,[m] Rhodesia,[n] Natal,[o] South Africa,[p] Orange River Colony,[q] Tasmania,[r] New Zealand,[s] New South Wales,[t] Victoria,[u] Queensland,[v] South Australia,[w] West Australia,[x] Straits Settlements,[y] Austria-Hungary, Belgium, France, Netherlands, and Switzerland,[z] practically all having special reference to importations from the United States because of peach yellows, black-knot, and pear-blight, as well as insect pests.

Canada[aa] has already taken action against the white-pine blister rust, together with other serious diseases, the principal features of the law being as follows: (1) Entry must be made through certain ports and at certain specified seasons; (2) nursery stock (in the widest sense) infested with specified insects or fungi is forbidden entry; (3) notice of shipment must be given the Minister of Agriculture by the consignor, by the transportation companies, and by customhouse brokers and other persons importing such stock; (4) certain stock may proceed to destination and then be inspected, but must not be unpacked except in the presence of an inspector; (5) diseased stock will be destroyed, together with packages and packing; (6) compensation of two-thirds the total value of the destroyed stock, packages, etc., shall be granted upon recommendation of the Minister; (7) it is illegal to dispose of diseased stock in any way, and the owner must send the Minister of Agriculture samples and a notice of the diseased condition immediately after the discovery of the disease; and (8) the importation of certain insects and fungi may be permitted for scientific purposes only.

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[a] Journal of the Board of Agriculture, London, vol. 14, 1907, p. 564, and vol. 15, 1908, pp. 304–305.

[b] Idem, vol. 15, 1908, p. 548.

[c] Eriksson, J. Journal of the Royal Horticultural Society, London, vol. 31, 1906, pp. 138–141.

[d] Salmon, E. S. Idem, pp. 128–137.

[e] Orton, W. A., and Field, Ethel C. Wart disease of the potato. Circular 56, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910, pp. 1–11.

[f] Journal of the Board of Agriculture, London, vol. 10, 1903, pp. 255–256.

[g] Idem, vol. 13, 1907, p. 760.

[h] Idem, vol. 14, 1908, p. 630.

[i] Idem, vol. 14, 1907, p. 311.

[j] Idem, vol. 13, 1907, p. 632; vol. 14, 1907, p. 330.

[k] Idem, vol. 11, 1904, p. 184.

There is every precedent in favor of action by the United States similar to that taken in Canada, and this seems to be the only available method of keeping the disease out of the country. Somerville (1909), of England, says the following concerning this matter:

> But if, by good chance, the disease has not yet reached America, the Governments of Canada and the United States ought to take a step that should have been taken earlier, namely, prohibit absolutely the importation of any plant of five-leaved pines or of any species of Ribes. Careful inspection and fumigation at the port of entry are

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[l] Lounsbury, C. P. The Agricultural Journal of the Cape of Good Hope, vol. 24, 1904, pp. 702–707.

[m] Journal of the Board of Agriculture, London, vol. 14, 1908, pp. 742–743.

[n] Idem, vol. 13, 1906, pp. 433–434.

[o] Idem, vol. 13, 1906, p. 499.

[p] Butler, F. D. Agricultural Gazette of New South Wales, vol. 18, 1907, pp. 629–631.

[q] Idem, vol. 18, 1907, p. 631.

[r] Idem, vol. 18, 1907, pp. 627–628.

[s] Journal of the Board of Agriculture, London, vol. 11, 1904, p. 306; vol. 13, 1906, p. 185.

[t] Butler, F. D. Op. cit., vol. 18, 1907, pp. 628–629.

[u] Idem, vol. 18, 1907, pp. 620–623.

[v] Idem, vol. 18, 1907, p. 623.

[w] Idem, vol. 18, 1907, pp. 623–625.

[x] Idem, vol. 18, 1907, pp. 625–627; Journal of the Board of Agriculture, London, vol. 13, 1906, p. 177.

[y] Lemon, A. H. Agricultural Bulletin, Straits and Federated Malay States, vol. 7, 1908, pp. 613–614.

[z] Howard, L. O. Circular 41, Division of Entomology, U. S. Dept. of Agriculture, entitled "Regulations of Foreign Governments Regarding the Importation of American Plants, Trees, and Fruits," 1900, pp. 1–4.

[aa] Memorandum, Department of Customs, Canada, May 11, 1910.

of no avail, for the fungus may be present for a year in the stems of the pines before showing itself on the surface as blisters.

Such authority given to the Secretary of Agriculture could be used effectively to compel nurseries to clean out the disease and would prevent their dumping infected stock into America, as has been done in the past and is even now being done.

While the various States are being forced to enact laws, which at best will handle this disease imperfectly, the disease will continue to be shipped throughout the country and will have every chance to obtain a secure foothold long before such laws become effective. Ignorance of the true state of affairs and indifference on the part of legislators usually give a new disease ample opportunity to become established. This is apparently true of the gooseberry mildew in Ireland and England and is more than likely to be true of the white-pine blister rust in this country unless preventive measures are taken by the National Government at once.

If this disease becomes established no effort adequate to handle it is ever likely to be exerted. A comparatively small expense at present will clean it entirely out of the country, while it can be easily kept out by a quarantine system. The annual expense of preventing further importations will not be as great as the amount already expended in trying to rid ourselves of a single year's importation of it. If the importation of white-pine nursery stock can not be absolutely prohibited, then the system of importation should be by permits, so that the Secretary of Agriculture will know of all shipments which enter the country.[a]

SUMMARY.

The reforestation movement, which is constantly and rapidly gaining in volume, has created a market for a considerable amount of young white-pine stock. The producing capacity of American nurseries has not kept pace with this demand. The prices for American trees are higher than European prices for the same grade of stock, this being caused partly by the lower cost of labor in Europe and partly by inexperienced management in America. White-pine nursery stock has been imported from Europe for years in limited quantities, but within the last five years the amount has increased very rapidly in spite of the obvious danger of introducing into this country some destructive insect or fungous pest.

Cronartium ribicola was discovered by Dietrich in 1855 in Russia and named by him. Klebahn in 1887 divided the pine-bark inhabiting *Peridermium pini* into three distinct species; i. e., *P. pini, P.*

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[a] See the Yearbook of the Department of Agriculture for 1909, p. 44.

cornui, and *P. strobi,* the latter being the form occurring on *Pinus strobus.* A little later Klebahn proved that *Peridermium strobi* on white pine is only one stage of *Cronartium ribicola,* which occurs on currant and gooseberry leaves. Other investigators corroborated his discovery. Still later it was proved that the Peridermia of *Pinus cembra, Pinus lambertiana,* and *Pinus monticola* are identical with *P. strobi* and are also stages of *Cronartium ribicola.*

The blister-rust fungus has been found to be present in Norway, Sweden, Finland, Russia, Siberia, Japan, Austria-Hungary, Italy, Switzerland, Germany, Denmark, France, Belgium, Holland, Scotland, and England. (See fig. 1.) In America it has been introduced into Kansas, New York, Vermont, New Hampshire, Massachusetts, Connecticut, Pennsylvania, Indiana, and Ohio, and it may be present in Minnesota and in Ontario, Canada. It is known to have been shipped to 230 different localities in North America.

Economically, the Cronartium stage of this fungus is of little importance, as it does not usually kill affected Ribes bushes. Its chief importance is due to its serving to spread the disease to pines. The Peridermium stage on pines causes much damage. It kills young trees and young branches on large trees, even killing old trees by depriving them of the small branches. The fungus can attack only branches or stems that are about 20 years old or younger. Cases are known where trees 100 years old have been killed by it, and many cases are known where trees from 10 years to 50 years old have been rendered unsightly and utterly spoiled for park purposes. In the forest the trees are stunted and sooner or later break over at the attacked place if they survive until they are 25 or 30 years old. In nurseries the greatest damage is done, entire beds and even the entire stock of nurseries being rendered unsalable. In a considerable number of instances the culture of the white pine has been abandoned because of this disease. Definite mention has been found of this disease occurring in the following nurseries in Germany at some time: Späth, Berlin, H. C. A. Helleman, Lilienthal, Metz & Co., Steglitz, and H. H. Pein, Halstenbek. This does not necessarily indicate that the disease is now present in these nurseries. Diseased stock has been received in America from Levavasseur & Fils, Ussy, E. T. Dickinson, Chatenay, and Barbier & Co., Orleans, France. But the firm of J. Heins Söhne, Halstenbek, Germany, has sent far the largest quantity. The disease has been further mentioned as occurring in nurseries near Berlin, Muskau, Eberswalde, Amelsbüren, Delmenhorst, Tharandt, Hamburg, and Mühlenbek, Germany; Paris, France; Stockholm, Sweden; and St. Petersburg, Russia. In three of these localities the disease occurred in nurseries of royal forestry institutions.

The life history of *Cronartium ribicola* is quite complicated. It may be very briefly stated as follows: The sporidia formed on the leaves of currants and gooseberries are blown about for some distance in the vicinity of the affected bushes. They alight on all parts of the white pines which happen to be near, and those which stick to the young bark germinate and the germ tube penetrates the bark. After it has once gotten within the bark tissues it is impossible to kill the fungus without killing the infected part of the host. Here it develops slowly for ten months or more, when the bark becomes raised in small blister-like patches which are more or less translucent. Finally small, round drops of a sticky, sweet, colorless fluid are exuded through small openings in the bark (fig. 3). These drops are full of tiny spores, called pycnospores. They are followed in the succeeding April, May, and early June by the Peridermium spores, which are produced in whitish, blistery elevations, which break open and set the orange-colored spores free (Pl. I, *A*; Pl. II, fig. 2). The Peridermium spores, in turn, are blown to plants of currants and gooseberries, where they germinate and infect the leaves. Here also two distinct forms of spores are produced; i. e., yellow spores, breaking out in tiny round pustules on the under side of the leaves (Pl. I, *B* and *C*), and later tendril-like threads, yellow and later turning brown, bearing large compound spores (Pl. I, *D*). The two forms are known, respectively, as uredospores and teleutospores. When the teleutospores germinate they immediately produce a third form of spore, known as sporidia, which is capable of infecting pines. The Peridermium spores, the pycnospores, and the uredospores can not infect pines; the first and last can infect currants and gooseberries. That is, it is necessary for both pines and Ribes to be near enough together to infect each other in order to have the disease reproduce itself. The fungus lives and fruits year after year on the pine until the tree dies, but on Ribes it falls with the leaves and has to reinfect the bush the next season.

The Peridermium stage is known to attack *Pinus strobus*, *P. cembra*, *P. monticola*, *P. excelsa*, and *P. lambertiana*, all five-leaved pines. It seems probable that it may also occur upon any or all the other five-leaved species of pine. These are *Pinus peuce*, *P. ayacahuite*, *P. strobiformis*, *P. scipioniformis*, *P. pentaphylla*, *P. parviflora*, *P. pumila*, *P. flexilis*, *P. albicaulis*, *P. koraiensis*, *P. armandii*, *P. balfouriana*, and *P. aristata*. The Cronartium stage has been found upon twenty-six species of Ribes, and apparently no species is entirely immune. There are at least twice this number of species of Ribes in the world, and so far as known they are all susceptible to the attacks of *Cronartium ribicola*. So far as our knowledge goes at present the fungus might spread throughout the North Temperate

Zone, since each of these two groups of plants within the combined ranges of its species includes nearly all this territory.

Considering the past record of this fungus, as well as that of others when introduced into new climates and upon new hosts, we may expect *Cronartium ribicola* to be more destructive in America, should it once become established, than it has already been in Europe. Moreover, it would finally affect not only the white-pine belt but also the mountain region west of the Mississippi River as well.

It is proposed to call the Cronartium stage of this fungus the "currant felt rust" and the Peridermium stage the "white-pine blister rust."

Affected young white pines are peculiarly stunted in appearance, the top having a thick, bunchy appearance (Pl. II); the new growth is usually shorter than normal (Pl. II, fig. 2); the leaves may be somewhat yellowed; the affected stem is thickened in a spindle-shaped swelling in most cases (Pl. I, *A*; figs. 3 and 4), while in others it is swollen the whole length of a year's growth, with irregular bunches at intervals (Pl. II, fig. 2). The long period of incubation renders a dock inspection of no value except in the case of trees which already have the disease well developed.

The situation is well in hand and there need be no undue apprehension if the persons concerned continue to follow up the careful inspection work already under way. The disease has been eradicated once with complete success and there is no reason why it can not be done again.

The diseased stock thus far seen has come from the firm of J. Heins Söhne, of Halstenbek, Germany, with the exception of four lots received from three French firms and which may not have been raised by them. Trees 3, 4, 5, 6, 7, and 10 years old with fruiting bodies of this fungus upon them, or with unmistakable signs of the disease, have been found in America.

Methods of preventing and combating this disease are briefly as follows: Stop importing five-leaved pine and Ribes stock and raise it at home; watch imported Ribes stock during the first season, and preferably the second also; keep five-leaved pines well separated from Ribes if either is imported (a distance of 500 feet is advisable); where the disease is already present all Ribes should be removed from the vicinity of the affected pines to a distance of 500 feet or more; remove and burn all diseased pine trees, making inspections from the last of April to June 10; inspect Ribes from July 1 until late in the fall, removing diseased bushes and burning them; inspect diseased lots of pines the second spring to detect such as may have developed the disease in the meantime; if any are found in the second season's inspection it will be necessary to make a third inspection to make sure that all diseased trees have been removed; when buying five-leaved pine stock, even in this country, require the seller to guarantee the stock to be free from this disease or else to have been raised in America.

The preference of this parasite for the five-leaved pines is of special significance to America, since these pines are naturally present through the western, northern, and northeastern forests and are planted more or less commonly thoughout the country. The chances for great losses if this fungus should even approximate its past record in Europe are very good. Estimates of possible damage show that such losses would very soon far exceed the total valuation of all coniferous stock ever imported into the country. If this disease becomes established in America the present really important reforestation movement will be unable to survive the addition of this last straw to its already large burden of difficulties. While the monetary cost of imported stock is less than that of American stock, the various items of expense which necessarily are incurred bring the two nearer together than would at first be thought. Moreover, the risks of injury from the long trip, and of importing destructive insect and fungous pests are so great as to deter any but the most venturesome from importing such stock.

The repeated inspection necessary for imported trees soon costs more than the original value of the stock. Under the present system of handling importations it is impossible to know whether diseased stock is being imported or not. Many other countries have laws regulating the importation of certain plants. Only the past spring Canada took measures against the white-pine blister rust, and similar action should be at once taken in this country. Such action should consist of the prohibition of the importation of five-leaved pines and of plants of Ribes. Failing this, it should be such as will keep the Department of Agriculture informed with absolute certainty about each and every such importation that is made; this would be accomplished by the permit system.

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1854. Tulasne, L. R. Second mémoire sur les Urédinées et les Ustilaginées. Annales des Sciences Naturelles, Botanique, ser. 4, vol. 2, p. 189.

Tulasne mentions the occurrence of a Cronartium on Ribes in India.

1856. Dietrich, H. A. Blicke in die Cryptogamenwelt der Ostseeprovinzen. Archiv für die Naturkunde Liv-, Esth-, und Kurlands, ser. 2, vol. 1, p. 287.

First time name was published; no description given; contains notes of occurrence on Ribes and *Pinus strobus* in the Baltic provinces of Russia.

1867. Oersted, A. S. Lövsporeplanterne.

The original has not been seen.

1872. Fischer von Waldheim, A. In Rabenhorst's Fungi Europaei exsiccati, no. 1595. Cited in Hedwigia, vol. 11, p. 182.

A description of the uredo stage of *Cronartium ribicola* is given on the label of the specimen.

1873 *a*. Magnus, P. Hedwigia, vol. 12, p. 52.

Cronartium ribicola was found upon *Ribes aurem* at Kiel, Germany, in 1872.

1873 *b*. ——— Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin, pp. 136–137.

Magnus found *Cronartium ribicola* on Ribes at Stralsund and Kiel, Germany, in 1872; also found in Denmark by Oersted; states that it apparently came from America.

1873. Oersted, A. S. System der Pilze, p. 33.

Bare citation under the name *Cronartium ribis.*

1874. Hartig, R. Wichtige Krankheiten der Waldbäume, p. 70, pl. 4, fig. 7.

Hartig mentions receiving specimens of Peridermium on branches of *Pinus strobus.*

1874 *a*. Magnus, P. Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin, pp. 21–22.

Magnus remarks on the sudden appearance of *Cronartium ribicola* where it was previously unknown.

1874 *b*. ——— Verhandlungen des Botanischen Vereins der Provinz Brandenburg, vol. 16, pp. 58–60.

A brief account of the discovery of *Cronartium ribicola* by Dietrich and its subsequent spread in Europe is given.

1874 *c*. ——— Botanische Zeitung, vol. 32, pp. 330–332.

The occurrence of *Cronartium ribicola* in various places is mentioned.

1874. Rostrup, E. Notiz über Cronartium ribicola. Botanische Zeitung, vol. 32, pp. 79–80.

A letter from Rostrup saying that this fungus was mentioned in a list of plants available for exchange among the members of the Botanical Society of Copenhagen in the spring of 1871.

1875. Schroeter, J. Ueber einige amerikanische Uredineen. Hedwigia, vol. 14, p. 167.

Schroeter says that *Cronartium ribicola* has never been found by Schweinitz or received by Berkeley from America and that it can not be an American fungus.

1876. Hisinger, Edward. Peridermium pini (Willd.) Pers. a corticola dödande Pinus strobus. Botaniska Notiser, p. 75.

Hisinger found *Cronartium ribicola* in 1869 killing 30-year-old white pines.

1876 *a*. Sorokin, N. Notiz über Verbreitung des Cronartium. Hedwigia, vol. 15, pp. 84–87.

Cronartium ribicola was found by Regel and Woronin at St. Petersburg, Russia; also by Stefankowo near Moscow. Sorokin found stylospores, and Schell found the fungus on Ribes in the Urals.

1876 *b*. ——— Hedwigia, vol. 15, pp. 145–146.

Sorokin found *Cronartium ribicola* on *Ribes aureum* but not on *R. nigrum;* inoculations did not succeed.

1877. Körnicke, F. Mykologische Beiträge. Hedwigia, vol. 16, p. 24.

Körnicke found *Cronartium ribicola* on Ribes near Konigsberg in East Prussia.

1877. Rostrup, E. Om de paa vore träagtige Planter, dog fortrinsvis paa Skovträerne opträdende Uredineer eller Rustsvampe. Tidsskrift for Skovbrug, vol. 2.

The original has not been seen.

1877. Wolff, R. Beitrag zur Kenntniss der Schmarotzerpilze. Landwirtschaftliche Jahrbücher, vol. 6, pp. 723–757.

In this paper on *Peridermium pini* mention is made of its occurrence on *Pinus strobus*.

1878. Arbois de Jubainville, A. d', and Vesque, J. Les maladies des plantes cultivées, pp. 186–187.

Incidental mention of *Cronartium ribicola* on *Pinus strobus* is made.

1878. Winter, G. Die durch Pilze verursachten Krankheiten der Kulturgewächse, pp. 111–114.

Peridermium pini is mentioned as occurring on *Pinus strobus*.

1880 *a*. Thümen, F. von. Beiträge zur Pilz-Flora Sibiriens, IV. Bulletin de la Société Impériale des Naturalistes de Moscou, vol. 55, p. 213.

Cronartium ribicola is mentioned as occurring on *Ribes rubrum* on the Inja River in Siberia.

1880 *b*. ——— Die Blasenrostpilze der Coniferen. Mittheilungen aus dem Forstlichen Versuchswesen Oesterreichs, vol. 2, pp. 310–311.

Peridermium pini is said to occur on the stems of *Pinus strobus* in Denmark, Germany, and Finland.

1880. Winter, G. Verzeichniss der im Gebiete von Koch's Synopsis beobachteten Uredineen und ihrer Nährpflanzen. Hedwigia, vol. 19, p. 55.

Note of the occurrence of *Cronartium ribicola*.

1883. Rostrup, E. Fortsatte Undersögelser over Snyltesvampes Angreb paa Skovtraeer. Tidsskrift for Skovbrug, vol. 6.

The original has not been seen.

1884. Winter, G. In Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich, und der Schweiz, vol. 1, p. 236. (Edition 2.)

Winter gives a description of *Cronartium ribicola*.

1885. Oudemans, C. A. J. A. Aanwinsten voor de flora mycologica van Nederland, IX–X. Nederlandsch Kruidkundig Archief, ser. 2, vol. 4, p. 239.

Notes occurrence of *Cronartium ribicola* in Holland.

1886. ——— Contributions à la flore mycologique des Pays-Bas, XI. Nederlandsch Kruidkundig Archief, ser. 2, vol. 4, p. 515.

Note of occurrence of *Cronartium ribicola* in Holland.

1887. Klebahn, H. Beobachtungen und Streitfragen über die Blasenroste. Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen, vol. 10, pp. 145–155, pl. 1, figs. 5–10, 13, and 14.

Klebahn splits up the old species *Peridermium pini corticolum* into three distinct species, one of which is *P. strobi*, which he distinguishes by its earliness of fruiting and the character of the spores.

1887. Schroeter, J. In Cohn's Kryptogamen-Flora von Schlesien, vol. 3, p. 373.

Gives places of occurrence of *Cronartium ribicola* in Silesia.

1888 *a*. Klebahn, H. Ueber den Rindenrost der Weymouthskiefer Peridermium (Aecidium) strobi. Botaniska Notiser, pp. 229–230.

A general statement of the heterœcism of *Cronartium ribicola*.

1888 *b*. ——— Weitere Beobachtungen über die Blasenroste der Kiefern. Berichte der Deutschen Botanischen Gesellschaft, vol. 6, pp. xlv–lv.

One of the best articles on *Cronartium ribicola;* general account of its life history and a description of the disease caused by it on the white pine.

1888. Nordstedt, O. Botaniska Notiser, p. 236.

Note of the occurrence of *Cronartium ribicola* in Sweden.

1888. Toni, J. B. de. In Saccardo's Sylloge fungorum, vol. 7, pp. 598–599, 837.

De Toni gives a scientific description of *Cronartium ribicola* in both stages.

1889. Klebahn, H. Bemerkung über den Weymouthskieferrost. Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen, vol. 10, pp. 427–428.

Klebahn announces the discovery of the alternate stage of the white-pine rust by successful inoculations on Ribes; also mentions a number of places in Germany where the fungus has been found.

1889. Schroeter, J. In Cohn's Kryptogamen-Flora von Schlesien, vol. 3, p. 373.

Schroeter gives a scientific description of *Cronartium ribicola* and notes its occurrence in Silesia.

1889. Ward, H. Marshall. Timber and some of its diseases, p. 258.

Ward mentions *Peridermium pini* as occurring on *Pinus strobus*.

1890. Eriksson, J. Om några sjukdomar å odlade växter. Kungliga Landtbruks-Akademiens Handlingar och Tidskrift, vol. 29, pp. 223–225.

An account of *Cronartium ribicola* in Sweden and the damage done.

1890 *a*. Klebahn, H. Ueber die Formen und den Wirtwechsel der Blasenroste der Kiefern. Berichte der Deutschen Botanischen Gesellschaft, vol. 8, pp. (59)–(70).

A statement of the knowledge of the Peridermiums formerly included in the old species *P. pini*.

1890 *b*. ——— Neue Untersuchungen und Beobachtungen über die Blasenroste der Kiefern. Hedwigia, vol. 29, pp. 27–35.

Klebahn describes *Peridermium pini, P. cornui*, and *P. strobi;* also gives the results of inoculations with the latter upon Ribes, spores from *Pinus lambertiana* being used successfully; mentions finding æcidiospores on April 16 and says that a tree which bore spermogonia in 1888 had æcidia in 1889.

1890. Poirault, G. Les Urédinées et leurs plantes nouricières. Journal de Botantique, vol. 4, pp. 249, 342.

Incidental mention of *Cronartium ribicola*.

1890 *a*. Rostrup, E. Det förste halve Hundrede af vaertskiftende Rustsvampe. Videnskabelige Meddelelser fra den Naturhistoriske Forening i Kjöbenhavn for Aaret 1889, pp. 242, 250.

Incidental mention of *Peridermium strobi*, with change of name to *P. klebahni*.

1890 *b*. Rostrup, E. Undersögelser over Snyltesvampes Angreb paa Skovtraeer 1883–1888. Tidsskrift for Skovbrug, vol. 12.

Original not seen.

1890. Wettstein, R. von. Ueber Ergebnisse von Culturversuchen mit heteröcischen Uredineen. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien, vol. 40, p. 44.

Note on inoculations completely corroborating Klebahn's statements as to the identity of *Peridermium strobi* and *Cronartium ribicola*.

1891. Comes, O. Crittogamia agraria, vol. 1, p. 121.

Comes barely mentions *Cronartium ribicola*.

1891. Dietel, P. Ueber die Fortschritte der Kenntnis von den Rostpilzen in den letzten zehn Jahren. Botanisches Centralblatt, vol. 47, p. 18.

Incidental mention of *Cronartium ribicola*.

1891. Gobi, C., and Tranzschel, W. Beiträge zur Pilzflora, Russlands. (German résumé.) Scripta Botanica Horti Universitatis Imperialis Petropolitanae, vol. 3, pp. 99–100, 121. (In Russian.)

The occurrence of *Cronartium ribicola* in various parts of Russia is noted.

1891. Hartig, R. Ueber die Klebahn'sche Abhandlung über die Formen des Peridermium pini. Botanisches Centralblatt, vol. 46, pp. 18–19.

A mere note.

1891 *a*. Magnus, P. Ueber den Rost der Weymouth-Kiefern, Pinus strobus L. Gartenflora, vol. 40, pp. 452–453.

An account of the white-pine blister rust as observed in Germany; Magnus mentions finding uredospores on May 26.

1891 *b*. ——— Ueber den Rost der Weymouth-Kiefern (Pinus strobus L.). Naturwissenschaftliche Rundschau, vol. 6, pp. 477–478.

A general account of the white-pine blister rust, with a statement of the damage sustained in different places in Germany.

1891. Sorauer, P. Peridermium strobi Kleb. Zeitschrift für Pflanzenkrankheiten, vol. 1, pp. 183, 366–367.

Results of inoculations on various species of Ribes are presented.

1892. (Anonymous.) Weymouth pine disease. Gardeners' Chronicle, ser. 3, vol. 11, p. 736.

The writer erroneously calls the fungus *Peridermium pini* and says that the alternate stage is probably on some composite.

1892. Hartig, R. Ueber die bisherigen Ergebnisse der Anbauversuche mit ausländischen Holzarten in den bayerischen Staatswaldungen. Forstlich-Naturwissenschaftliche Zeitschrift, vol. 1, p. 443.

1892 *a*. Klebahn, H. Kulturversuche mit heteröcischen Uredineen. Zeitschrift für Pflanzenkrankheiten, vol. 2, pp. 332–334.

Summary of inoculations with spores of *Peridermium strobi* upon various species of Ribes by himself and previous authors.

1892 *b*. ——— Weymouth pine fungus. Gardeners' Chronicle, ser. 3, vol. 12, p. 133, figs. 22–23.

Klebahn correctly names the fungus and says that Plowright has just discovered the Cronartium stage in England for the first time.

1892. Ludwig, Friedrich. Lehrbuch der niederen Kryptogamen, p. 469.

Cronartium ribicola is barely mentioned.

1892. Oudemans, C. A. J. A. Révision des champignons dans les Pays-Bas, vol. 1, pp. 511, 584–585.

Note of occurrence of *Cronartium ribicola* in Holland.

1892 *a*. Plowright, Charles B. Fungus on Weymouth pine and on currants. Gardeners' Chronicle, ser. 3, vol. 12, p. 44.

Specimens submitted to Klebahn were pronounced to be *Peridermium strobi*.

1892 *b*. PLOWRIGHT, CHARLES B. Cronartium ribicola. Gardeners' Chronicle, ser. 3, vol. 12, pp. 137, 501.

Plowright found this for the first time in England on July 3, 1892. He later found the Peridermium stage on white pines near rusted currant bushes.

1892. SCHWARZ, FRANK. Forstliche botanik, p. 222.

Brief statement regarding the white-pine rust.

1892. WARD, H. MARSHALL. The diseases of conifers. Journal of the Royal Horticultural Society, vol. 14, pp. 134–136.

Follows Klebahn in considering *Peridermium strobi* a distinct species.

1893. FRANK, A. B., and SORAUER, P. Jahrbuch der Deutschen Landwirtschafts-Gesellschaft, vol. 8, pp. (430) and (441).

Note of occurrence of *Cronartium ribicola* near Bremen.

1893 *a*. KLEBAHN, H. Kulturversuche mit heteröcischen Uredineen. Forstlich-Naturwissenschaftliche Zeitschrift, vol. 2, pp. 69–72.

Klebahn says that *Ribes grossularia* is immune to *Cronartium ribicola* but when grafted on *R. aurem* it becomes susceptible.

1893 *b*. ——— Zur Kenntnis der Schmarotzer-Pilze Bremens und Nordwestdeutschlands. Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen, vol. 12, pp. 372–373.

Klebahn says that spermogonia of *Peridermium strobi* occur similarly to those of *P. pini* on *Pinus sylvestris*.

1893. NILSSON, A. Forstligt botaniska undersökningar i sydöstra Nerike, 1892. Tidsskrift for Skogshushållning, p. 65.

Note of occurrence of *Cronartium ribicola* in Sweden on Ribes, but Nilsson says that white pine was absent for at least three-fourths of a mile.

1893. PLOWRIGHT, C. B. Peridermium strobi. Gardeners' Chronicle, ser. 3, vol. 13, p. 425.

Plowright found the fungus on white pine near the diseased Ribes bushes which he had previously found.

1893. SORAUER, P. Jahrbuch der Deutschen Landwirtschafts-Gesellschaft, vol. 8, p. 440.

Found *Peridermium strobi* on white pine but not on *Pinus cembra*.

1894. HARTIG, R. Textbook of the diseases of trees, pp. 173–175. (Translated by Somerville, William, and Ward, H. Marshall.)

Brief mention of the white-pine blister rust.

1894. TRANZSCHEL, W. Sitzungsbericht der Naturforscher-Gesellschaft zu St. Petersburg, vol. 21, p. 22. (In Russian; the original has not been seen.)

1895. ERIKSSON, J. Rostsjukdon a Weymouthstallen. Svenska Trädgårdsföreningens Tidskrift, p. 88.

The original has not been seen.

1895 *a*. KLEBAHN, H. Kulturversuche mit heteröcischen Rostpilzen, III. Zeitschrift für Pflanzenkrankheiten, vol. 5, pp. 73–74.

Successfully inoculated *Cronartium ribicola* on *Ribes grossularia* when the latter was grafted on *R. aureum*.

1895 *b*. ——— Kulturversuche mit heteröcischen Rostpilzen, IV. Zeitschrift für Pflanzenkrankheiten, vol. 5, p. 260.

Klebahn found that the spermogonia of *Cronartium ribicola* are formed the summer after infection takes place, while the æcidia are produced the second summer.

1895. PRILLIEUX, ED. Maladies des plantes agricoles, vol. 1, pp. 275–276.

A brief statement of the heterœcism of *Cronartium ribicola*.

1895. Rostrup, E. Mykologiske Meddelelser, V. Botanisk Tidsskrift, vol. 19, pp. 215–216.

Rostrup successfully inoculated Ribes with spores from *Pinus strobus*.

1895. Schøyen, W. M. Beretning om Skadeinsekter og Plantesygdomme i 1894, p. 34.

Found *Cronartium ribicola* upon *Pinus strobus:* made successful inoculations upon Ribes.

1895. Tubeuf, C. von. Pflanzenkrankheiten durch kryptogame Parasiten verursacht, p. 395.

A good general account of the white-pine blister rust.

1896. Blytt, Axel. Bidrag til Kundskaben om Norges Soparter. Forhandlinger i Videnskabs-Selskabet i Christiania, p. 70.

Note of occurrence of *Cronartium ribicola* in Norway.

1896 *a*. Eriksson, J. Einige Beobachtungen über den stammbewohnenden Kiefernblasenrost, seine Natur und Erscheinungsweise. Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten, pt. 2, vol. 2, pp. 377–394.

A good general account of *Cronartium ribicola* and its life history with methods of treatment.

1896 *b*. ——— Några iakttagelser rörande blåsrosten å tallstammar dess natur och förekomstätt. Kungliga Landtbruks-Akademiens Handlingar och Tidskrift, vol. 35, pp. 240–258.

Practically the same as the preceding work.

1896. Frank, A. B. Die Krankheiten der Pflanzen, vol. 2, p. 186. (2d ed.)

A brief statement of heterœcism of *Cronartium ribicola*.

1896. Schøyen, W. M. Beretning om Skadeinsekter og Plantesygdomme i 1895, p. 28.

Note of occurrence of *Cronartium ribicola* in Sweden.

1897. Brick, C. Beitrag zur Pilzflora des Sachsenwaldes. Verhandlungen des Naturwissenschaftlichen Vereins in Hamburg, ser. 3, vol. 5, p. 28.

Notes the occurrence of the disease upon Ribes and white pine in the forests of Saxony.

1897. Bubák, Franz. Ein Beitrag zur Kenntniss der böhmischen Peronosporeen, Ustilagineen und Uredineen. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien, vol. 47, p. 233.

Note of occurrence of *Cronartium ribicola* in Bohemia.

1897. Frank, A. B. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1896, p. 122. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Silesia.

1897 *a*. Klebahn, H. Neuere Beobachtungen über einige Waldschädlinge aus der Gruppe der Rostpilze. Forstlich-Naturwissenschaftliche Zeitschrift, vol. 6, pp. 465–473.

Incidental mention of *Cronartium ribicola*.

1897 *b*. Klebahn, H. Kulturversuche mit heteröcischen Rostpilzen, VI. Zeitschrift für Pflanzenkrankheiten, vol. 7, p. 343.

Inoculated *Pinus strobus, Ribes nigrum,* and *Vincetoxicum officinale* with æcidiospores from the first; only the Ribes was infected.

1897. Schøyen, W. M. Beretning om Skadeinsekter og Plantesygdomme i 1896, p. 56.

Note of occurrence of *Cronartium ribicola* in Sweden.

1897 *a*. Tubeuf, C. von. Ueber die Verbreitung von Pflanzenkrankheiten. Die Gefahr der Ausdehnung des Rindenblasenrostes der Weymouthskiefer. Forstlich-Naturwissenschaftliche Zeitschrift, vol. 6, pp. 320–324 and figs. 1–3.

Good general account of the distances to which the white-pine blister rust spores are distributed.

1897 *b*. Tubeuf, C. von. Die Nadelhölzer, p. 38.

Von Tubeuf cautions against growing the two hosts of *Cronartium ribicola* in proximity to each other.

1897. ——— and Smith, W. G. Diseases of plants induced by cryptogamic parasites, p. 382.

Brief account of the life history of *Cronartium ribicola* and of the disease caused by it.

1898 *a*. Fischer, Ed. Beiträge zur Kenntniss der schweizerischen Rostpilze. Bulletin de l'Herbier Boissier, vol. 6, pp. 16–17.

Found *Cronartium ribicola* on *Ribes petraeum* in Switzerland, but no white pines were in the vicinity.

1898 *b*. ——— Beiträge zur Kryptogamenflora der Schweiz, vol. 1, pp. 90–91.

Incidental mention of *Cronartium ribicola*.

1898. Hollrung, M. Jahresbericht über die Neurerungen und Leistungen auf dem Gebiete des Pflanzenschutzes, vol. 1, pp. 4–5.

Official notice to nurserymen regarding growing the alternate hosts of *Cronartium ribicola* together.

1898. Klebahn, H. Ueber den gegenwärtigen Stand der Biologie der Rostpilze. Botanische Zeitung, vol. 56, pt. 2, p. 149.

Incidental mention of *Cronartium ribicola*.

1898. Laurie, James. Gardeners' Chronicle, ser. 3, vol. 23, p. 244.

Describes the blister rust as spreading over all of the trees of *Pinus monticola* at Murthly Castle, Perth, Scotland, but not occurring on the white pine and not noted on Ribes. Trees 60 feet high and less were affected.

1898. Magnus, P. Ueber die Beziehungen zweier auf Stachys auftretenden Puccinien zu einander. Berichte der Deutschen Botanischen Gesellschaft, vol. 16, pp. 384–385.

Incidental mention of *Cronartium ribicola*.

1898–9. Plowright, C. B. On the recent addition to our knowledge of the Uredineæ and Ustilagineæ, with special reference to British species. Transactions, British Mycological Society, 1898–9, p. 103.

1898. Smith, W. G. A dangerous disease of the Weymouth pine. Gardeners' Chronicle, ser. 3, vol. 23, p. 202.

Smith says that *Cronartium ribicola* is being imported from Germany into England on nursery stock; cites specific instances of damage.

1898 *a*. Tubeuf, C. von. Der Rindenblasenrost der Weymouthskiefer, eine Gefahr für Garten und Wald. Praktische Blätter für Pflanzenbau und Pflanzenschutz, vol. 1, pp. 11–13 and figs. 1–3.

A very good popular account of the white-pine blister rust.

1898 *b*. ——— Vernichtung des Weymouthskiefernrostes. Praktische Blätter für Pflanzenbau und Pflanzenschutz, vol. 1, p. 63.

Methods of prevention and treatment of white-pine blister rust are given.

1899. (Anonymous.) Bladder rust of Pinus strobus. Gardeners' Chronicle, ser. 3, vol. 26, pp. 72–73.

Specimens of diseased white pine were sent from England to the Imperial Sanitary Office in Berlin, which said that attention had been repeatedly called to this disease two years before.

1899. Bartholomew, Elam. Kansas Uredineæ. Transactions, Kansas Academy of Science, vol. 16, p. 193.

Note of occurrence of *Uredo confluens* in Kansas (since identified as the uredo stage of *Cronartium ribicola*).

1899. Klebahn, H. Kulturversuche mit heteröcischen Rostpilzen, VII. Zeitschrift für Pflanzenkrankheiten, vol. 9, pp. 16–17.

Klebahn made repeated spermogonial inoculations without result.

1899. Massee, George. Weymouth pine rust. A textbook of plant diseases, pp. 233–234.

A brief general account of the disease on white pine.

1899. Plowright, Charles B. Bladder rust of Pinus strobus. Gardeners' Chronicle, ser. 3, vol. 26, pp. 72–73, 94.

Plowright collected *Cronartium ribicola* at King's Lynn, England, on *Pinus strobus.*

1899. Sorauer, P. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1898, p. 122. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Mecklenburg, Germany.

1899. Spalding, V. M., and Fernow, B. E. The white pine. Bulletin 22, Division of Forestry, U. S. Dept. of Agriculture, p. 53.

The white-pine blister rust is mentioned, but it is not stated that it is not present in America.

1899. Speschneff, N. N. Arbeiten des Botanischen Gartens zu Tiflis. (Reviewed in Zeitschrift für Pflanzenkrankheiten, vol. 9, p. 357.)

Note of occurrence of *Cronartium ribicola* in Tiflis. The original has not been seen.

1899. Vanderyst, H. Quelques nouvelles stations d'Ustilaginées et d'Urédinées. Revue Générale Agronomique, vol. 8, p. 61.

Note of occurrence of *Uredo confluens* in Belgium; later identified as *Cronartium ribicola.*

1899. Weiss, J. E. Weymouthskiefern-Blasenrost. (Peridermium strobi.) Praktische Blätter für Pflanzenbau und Pflanzenschutz, vol. 2, pp. 52–53.

Cautions nurserymen against sending out diseased white-pine stock.

1900. Dietel, P. In Engler and Prantl's Die Natürlichen Pflanzenfamilien, vol. 1, pt. 1**, p. 41 and fig. 26.

Scientific description of *Cronartium ribicola.*

1900. Fischer, Ed. Die Rostkrankheiten der forstlich wichtigsten Nadelhölzer nach dem heutigen Stande unserer Kenntnisse. Schweizerische Zeitschrift für das Forstwesen, vol. 51, pp. 192–193.

Says *Cronartium ribicola* is unknown in Switzerland on the white pine, but has been found on *Ribes petraeum.*

1900. Hess, R. Der Forstschutz, vol. 2, pp. 266–267.

Says *Cronartium ribicola* is very destructive to white pine; that stems more than 20 to 25 years old are not attacked; recommends that buyers require nurserymen to give guarantee of health of stock sold.

1900. Iwanoff, K. S. Die im Sommer 1898 bei Petersburg (Russland) beobachteten Krankheiten. Zeitschrift für Pflanzenkrankheiten, vol. 10, p. 99.

Note of occurrence of *Cronartium ribicola* in St. Petersburg, Russia.

1900. Jaap, Otto. Verzeichnis der bei Triglitz in der Prignitz beobachteten Ustilagineen, Uredineen und Erysipheen. Verhandlungen des Botanischen Vereins der Provinz Brandenburg, vol. 42, p. 263.

Note of occurrence of *Cronartium ribicola* in Brandenburg, Germany.

1900. Mayr, Heinrich. Naturwissenschaftliche und forstliche Studien im nordwestlichen Russland. Allgemeine Forst- und Jagd-Zeitung, vol 76, p. 122.

States that the white pine is much less clutivated in Russia than in Germany * * * "the blister rust is unfortunately very frequent."

1900. Nypels, Paul. Le Peridermium du Weymouth. Bulletin de la Société Centrale Forestière de Belgique, vol. 7, pp. 577–579.

The white-pine blister rust has spread rapidly in Belgium during the last few years.

1900*a*. Vanderyst, H. Quelques nouvelles stations d'Urédinées. Revue Générale Agronomique, vol. 9, p. 155.

Note of occurrence of *Cronartium ribicola* in Belgium.

1900 *b*. Vanderyst, H. Les Urédinées observées en Belgique. Revue Générale Agronomique, vol. 9, p. 364.

Cronartium ribicola was first found in Belgium in 1898 and has since spread rapidly.

1900. Ward, H. Marshall. The diseases of conifers. Veitch's Manual of the Coniferæ, p. 62. (Revised ed.)

Gives a brief account of the blister rust of white pine.

1900. Weiss, J. E. Cronartium ribicolum, der Säulenrost der Johannisbeere und Peridermium strobi, der Weymouthskiefern-Blasenrost. Praktische Blätter für Pflanzenbau und Pflanzenschutz, vol. 3, pp. 75–76.

Weiss recommends buying trees which are four are five years old, as the white-pine blister rust will have shown by that time, if the trees are diseased.

1901. Aderhold, R. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1900, p. 190. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Silesia.

1901. Brick, C. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1900, p. 190. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Lübeck.

1901. Marchal, Émile. Rapport sur les maladiés cryptogamiques in 1900. Bulletin de l'Agriculture, vol. 17, pp. 7–10.

Note of occurrence of *Cronartium ribicola* in Belgium in 1900.

1901. Reh, L. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1900, p. 190. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Hamburg.

1901. Ritzema Bos, J. Landbouwkundig Tijdschrift, vol. 9, p. 77.

Peridermium strobi is so widespread in Holland that the culture of white pine has been given up. The original work has not been seen.

1901. Schøyen, W. M. Beretning om Skadeinsekter og Plantesygdomme i 1900, pp. 24–25.

An account of the currant felt rust upon Ribes: Schøyen advises against growing the two hosts together.

1901. Sorauer, P. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1900, p. 1900. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Westphalia, Germany.

1901*a*. Tubeuf, C. von. Infektionsversuche mit Peridermium strobi dem Blasenroste der Weymouthskiefer. Arbeiten aus der Biologischen Abteilung für Land- und Forstwirthschaft am Kaiserlichen Gesundheitsamte, vol. 2, pp. 173–175.

Summary of infection experiments by various authors with *Peridermium strobi* spores upon Bibes.

1901 *b*. ——— Ueber Tuberculina maxima, einen Parasiten des Weymouthskiefern-Blasenrostes. Arbeiten aus der Biologischen Abteilung für Land- und Forstwirthschaft am Kaiserlichen Gesundheitsamte, vol. 2, pp. 169–173.

Account of *Tuberculina maxima* occurring as a parasite upon *Peridermium strobi*.

1901 *c*. ——— Einiger Beobachtungen über die Verbreitung parasitärer Pilze durch den Wind. Arbeiten aus der Biologischen Abteilung für Land- und Forstwirthschaft am Kaiserlichen Gesundheitsamte, vol. 2, pp. 175–177.

An account of the distribution of fungous spores by the wind, with particular mention of *Cronartium ribicola*.

1901. Weiss, J. E. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1900, p. 190. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Bavaria, Germany.

1902. Brick, C. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1901, p. 208. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Hamburg and Lübeck.

1902 *a*. Hennings, P. Ueber das epidemische Auftreten von Cronartium ribicola Dietr. im Dahlemer botanischen Garten. Notizblatt des Königlichen Botanischen Gartens und Museums zu Berlin, vol. 3, no. 28, pp. 172–175.

Gives observations on *Cronartium ribicola* around Berlin, with a list of Ribes found affected.

1902 *b*. ——— Beobachtungen über das verschiedene Auftreten von Cronartium ribicola Dietr. auf verschiedenen Ribes-Arten. Zeitschrift für Pflanzenkrankheiten, vol. 12, pp. 129–132.

Nearly the same as the above.

1902. Kirchner, O. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1901, p. 208. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Wurttemberg.

1902. Klebahn, H. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1901, p. 208. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Schleswig-Holstein and Hamburg.

1902. Magnus, P. Ueber Cronartium ribicola Dietr. Notizblatt des Königlichen Botanischen Gartens und Museums zu Berlin, vol. 3, no. 29, pp. 183–185.

Gives an account of Tranzschel's work in inoculating Ribes with spores from *Pinus cembra*.

1902. Marchal, Émile. In Belgien im Jahre 1901 beobachtete pilzparasitäre Krankheiten. Zeitschrift für Pflanzenkrankheiten, vol. 12, p. 49.

Note of occurrence of *Cronartium ribicola* in Belgium.

1902. Rea, Carleton. Transactions, British Mycological Society, 1900–1901, p. 164.

Note of occurrence of *Cronartium ribicola* at Exeter, England.

1902. Reh, L. Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten, 3d ed., vol. 19, p. 130.

Note of occurrence of *Cronartium ribicola* in Oldenburg.

1902. Ritzema Bos, J. Verslag over onderzoekingen, gedaan in-en over inlichtingen gegeven van wege bovengenoemd laboratorium in het jaar 1901. Tijdschrift over Plantenziekten, vol. 8, p. 22. (In Dutch; the original not read.)

1902. Rostrup, E. Plantepatologi, pp. 308–313 and figs. 124–127. (In Danish.)

Made successful inoculations with *Peridermium strobi* from white pine onto *Ribes gracile*, *R. divaricatum*, and *R. multiflorum;* about 1877 there was a severe outbreak upon 20 to 30 year old white pine. In a footnote he says he has found Peridermium upon *Pinus excelsa*, implying that it was *P. strobi* but not definitely saying so. Recommends the separation of the two host genera and the removal of all diseased branches and stems.

1902. Sorauer, P. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1901, p. 208. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Berlin.

1903. Berg, A. Bekaempelsen af Plantesygdomme og skadelige Insekter.

The original has not been seen.

1903. Bondarzev, A. S., and Bucholtz, F. Die Pilzparasiten des Sommers 1902 in der Umgebung von Riga. Zeitschrift für Pflanzenkrankheiten, vol. 13, p. 220.

Note of occurrence of *Cronartium ribicola* at Riga, Russia.

1903. Ewert, R. Das Auftreten von Cronartium ribicolum auf verschiedenen Ribes-Arten in den Anlagen des Kgl. Pomologischen Instituts zu Proskau. Zeitschrift für Pflanzenkranheiten, vol. 13, pp. 92–93.

The white-pine blister rust is very widespread in the protective plantings of the Pomeranian Institute, even old trees being affected. Gives lists of diseased and immune Ribes.

1903. Fox, William F. Forest nurseries and nursery methods in Europe. Reports 8 and 9, New York Forest, Fish, and Game Commission, pp. 201–235.

1903. Hennings, P. Beitrag zur Pilzflora des Gouvernements Moskau. Hedwigia, vol. 42, Beiblatt, p. (109).

Note of occurrence of *Cronartium ribicola* at Moscow, Russia.

1903. Kempton, H. B. The planting of white pine in New England. Bulletin 45, Bureau of Forestry, U. S. Dept. of Agriculture, p. 10.

1903. Marchal, Émile. Rapport sur les observations effectuées par le Service Phytopathologique de l'Institut Agricole de l'Etat en 1902. Bulletin de l'Agriculture, vol. 19, p. 169.

Note of occurrence of *Cronartium ribicola* in Belgium.

1903. Ritzema Bos, J. Verslag over onderzoekingen gedaan in-en over inlichtingen gegeven van wege bovengenoemn laboratorium in het jaar 1902. Tijdschrift over Plantenziekten, vol. 9, pp. 11–12. (In Dutch; original not read.)

1903. Schøyen, W. M. Beretning om Skadeinsekter og Plantesygdomme i 1902, p. 21.

Note of occurrence of *Cronartium ribicola* in Sweden in 1902.

1903. Staritz, R. Beiträge zur Pilzkunde des Herzogtums Anhalt. Verhandlungen des Botanischen Vereins der Provinz Brandenburg, vol. 45, p. 73.

Note of occurrence of *Cronartium ribicola* in Saxony.

1903. Thaler. Waldschädlinge des Jahres 1902. Allgemeine Forst- und Jagd-Zeitung, vol. 79, p. 404.

A number of head foresters reported that white-pine seedlings bought of private nurseries were diseased with the blister rust; part of the plants showed the disease the second spring after being planted out. Thaler cautions against buying diseased stock.

1904. Brick, C. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1903, pp. 151–152. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Hamburg.

1904. Dietel, P. Betrachtungen die Verteilung der Uredineen auf ihren Nährpflanzen. Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten, pt. 2, vol. 12, pp. 218–234.

Statement of heterœcism of *Cronartium ribicola.*

1904. Endler. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1903, pp. 151–152. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Saxony.

1904. Ewert, R. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1903, pp. 151. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in upper Silesia.

1904. Fischer, Ed. Die Uredineen der Schweiz, pp. xxxii, xl, xlvi, lxxxi, 433–436.

Notes of occurrence of *Cronartium ribicola* in Switzerland on *Pinus cembra* and Ribes.

1904. Jaap, Otto. Erster Beitrag zur Pilzflora der Umgegend von Putlitz. Verhandlungen des Botanischen Vereins der Provinz Brandenburg, vol. 46, p. 129.

Note of occurrence of *Cronartium ribicola* in Brandenburg, Germany.

1904. Jaczewski, A. A. Yezhegodnik sviedienii o boliezniakh i povrezhdeniiakh kulturnykh i dikorastushchykh poleznykh rastenii, vol. 1, p. 111–112. (In Russian.) Reviewed by Bessey, E. A., in Journal of Mycology, 1905, vol. 11, p. 175.

An account of the life history of *Cronartium ribicola*, with notes of occurrence in Livland, Poland, Kursk, and St. Petersburg, Russia, and in Tomsk, Siberia.

1904 *a*. Klebahn, H. Die wirtwechselnden Rostpilze, pp. 15–17, 21–22, 25, 26, 40, 41, 45, 78–81, 94, 111, 134, 142, 164, 186, 191, 194, 196, 382–387.

The most complete account of *Cronartium ribicola* and the disease caused by it; gives list of first occurrences in different European countries, list of pines, and list of Ribes known to have been diseased.

1904 *b*. ——— Jahresbericht des Sonderausschusses für Pflanzenschutz, 1903; pp. 151–152. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Schleswig-Holstein, Germany.

1904. Kornauth, K. Pathologische Vorkommnisse in Österreich–Ungarn. Zeitschrift für Pflanzenkrankheiten, vol. 14, p. 353.

Note of occurrence of *Cronartium ribicola* in Bohemia.

1904. Noack, F. Phytopathologische Beobachtungen aus Belgien und Holland. Zeitschrift für Pflanzenkrankheiten, vol. 14, p. 349.

Note of destructive occurrence of *Cronartium ribicola* in Holland.

1904. Schellenberg, D. H. C. Der Blasenrost der Arve. Naturwissenschaftliche Zeitschrift für Land- und Forstwirtschaft, vol. 2, pp. 233–241 and fig. 2.

The best account of *Peridermium strobi* upon *Pinus cembra*.

1904. Schüle, W. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1903, pp. 151–152. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Alsace, Germany.

1904. Weiss, J. E. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1903, pp. 151–152. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Bavaria, Germany.

1905. Jaap, Otto. Beiträge zur Pilzflora von Mecklenburg. Annales Mycologici, vol. 3, p. 396.

Note of occurrence of *Cronartium ribicola* in Mecklenberg.

1905. Jaczewski, A. A. Listok dlia barby s boliezniami i povrezhdeniami kulturnykh i dikorastushchykh poleznykh rastenii, vol. 4, no. 7, pp. 61–64. (In Russian.)

Describes the effects of *Cronartium ribicola* upon diseased Ribes; when the leaves are shed prematurely the fruit shrivels, and the bushes finally die if the disease recurs year after year. Experiments have shown that the teleutospores can not infect Ribes. Inoculations on Ribes at the end of May gave uredospores in the middle of July and teleutospores in August.

1905 *a*. Klebahn, H. Kulturversuche mit Rostpilzen, XII. Zeitschrift für Pflanzenkrankheiten, vol. 15, pp. 85–92 and pl. 3.

Account of successful inoculation of *Pinus strobus* with teleutospores of *Cronartium ribicola*.

1905 *b*. ——— Jahresbericht des Sonderausschusses für Pflanzenschutz, 1904, p. 171. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Germany.

1905. Lüstner, G. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1904, p. 171. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Hesse.

1905. Marchal, Émile. Rapport sur les observations effectuées par le Service Phytopathologique de l'Institut Agricole de l'Etat en 1904. Bulletin de l'Agriculture, vol. 21, p. 75.

Note of occurrence of *Cronartium ribicola* in Belgium on *Pinus strobus*.

1905. Oppenau. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1904, p. 171. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Baden.

1905. Schüle, W. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1904, p. 171. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Alsace.

1905. Spieckermann, A. Jahresbericht des Sonderausschusses für Pflanzenschutz, 1904, p. 171. In Arbeiten der Deutschen Landwirtschafts-Gesellschaft.

Note of occurrence of *Cronartium ribicola* in Westphalia.

1905 *a*. Tubeuf, C. von. Über die Biologie, praktische Bedeutung und Bekämpfung des Weimutskiefern-Blasenrostes. Kaiserliche Biologische Anstalt für Land- und Forstwirtschaft, Flugblatt, no. 5, pp. 1–4, and col. pl. 1.

A very good popular account of the white-pine blister rust and the disease caused by it, with recommendations for combating it. A translation by A. J. T. van Laer was published by the New York State Department of Agriculture in 1909.

1905 *b*. ——— In Lafar's Handbuch der technischen Mykologie, vol. 3, pp. 296–297.

Incidental mention of *Cronartium ribicola*.

1905 *c*. ——— Der Blasenrost der Weymouthskiefer. (A colored chart 16 by 19 inches, with sixteen figures, showing various stages of the fungus and the disease. Issued by the Biologische Abteilung des Kaiserlichen Gesundheitsamtes. This chart has been distributed to inspectors and others by the Bureau of Plant Industry. See page 50.)

1905. Voglino, P. Patologia vegetale, p. 209.

Statement of heterœcism of *Cronartium ribicola*.

1906. Appel, Otto. Der Weymouthskiefern-Blasenrost. Mittheilungen aus der Kaiserlichen Biologischen Anstalt für Land- und Forstwirtschaft in Dahlem bei Steglitz, vol. 2, p. 20.

Appel says that successful inoculations have been made on about forty species of Ribes, but does not name them.

1906. Bondarzev, A. S. Rastitelnyie parazity kulturnykh i dikorastushchykh rastenii. Sobranie v Kurskoi gubernii lyetom 1901, 1903–1905 godov. Acta Horti Petropolitani, vol. 26, pp. 19, 40.

Found year after year in the same gardens on Ribes in Kursk, Russia; no *Pinus cembra* or *P. strobus* known in the vicinity.

1906. Jaczewski, A. A. Yezhegodnik sviedienii o boliezniakh i povrezhdeniiakh kulturnykh i dikorastushchykh poleznykh rastenii, vol. 2, pp. 85–86, 98. (In Russian.)

Inoculations upon *Ribes rubrum*, *R. nigrum*, and *R. grossularia* with æcidiospores from *Pinus strobus* were successful only on the first. Found on *Ribes nigrum* in the Governments of Kursk, Tula, and Orlov; on *Pinus strobus* in the Governments of Livland, Smolensk, and Moscow; on *Pinus cembra* in the Government of St. Petersburg, Russia.

1906. Mayr, Heinrich. Fremdländische Wald- und Parkbäume für Europa, pp. 374–375, 587.

States that ten years ago the disease was sent in some trees to the Forestry Experiment Garden at Grafrath; they were removed and burned two years later, when the disease appeared.

1906. Neger, F. W. Über Peridermium strobi auf Pinus monticola Dougl. Annales Mycologici, vol. 4, p. 280.

Neger found the white-pine rust on *Pinus monticola* at Tharandt, Germany.

1906. P———y. Ein neuer Feind unserer Weymouthskiefernkulturen. Schweizerische Zeitschrift für das Forstwesen, vol. 57, pp. 46–48.

The writer says that the white pine grows well in the high Juras, but that lately a new enemy, the blister rust, has appeared; it mostly kills trees six or seven years of age, but older ones are merely stunted in growth; he recommends raising one's own seedlings and the removal of Ribes from the vicinity.

1906 *a*. Rostrup, E. Cronartium paa Ribes aureum. Gartner-Tidende, August 30.

The original has not been seen.

1906 *b*. ——— Cronartium paa Stikkelsbärblade. Gartner-Tidende, November 22.

The original has not been seen.

1906. Stewart, F. C. An outbreak of the European currant rust (Cronartium ribicola Dietr.). Tech. Bulletin 2, New York Agricultural Experiment Station (Geneva), pp. 61–74.

A very good account of the Cronartium stage of *C. ribicola* as discovered by Stewart in the experiment station currant plantation; the origin of the outbreak is unknown. The entire plantation was uprooted and burned and the fungus apparently completely eradicated.

1906. Takahashi, Y. Notes on some parasitic fungi of Japan. Transactions of the Sapporo Natural History Society, vol. 1, pp. 177–179, 181.

States that *Cronartium ribicola* has been found on *Ribes rubrum* at Sapporo, Japan, and on Sakhalin Island, but the æcidial stage has not been found.

1907 *a*. (Anonymous.) Krankheiten und Beschädigungen der Kulturpflanzen im Jahre 1905. Berichte über Landwirtschaft, vol. 5, pp. 142, 154.

A condensed statement of the occurrence of *Cronartium ribicola* in various parts of Germany in 1905.

1907 *b*. (Anonymous.) Journal of the Board of Agriculture (London), vol. 14, pp. 480–481.

Found *Cronartium ribicola* on *Ribes nigrum* at Westbury, England.

1907. Arthur, J. C. North American flora, vol. 7, pp. 122–123.

Scientific description of *Cronartium ribicola.*

1907. Bruck, W. F. Pflanzenkrankheiten, pp. 26, 91, 130.

Statement of hosts and heterœcism of *Cronartium ribicola.*

1907. Fischer, Ed. Ueber die durch parasitische Pilze (besonders Uredineen) hervorgerufenen Missbildungen. Verhandlungen der Schweizerischen Naturforschenden Gesellschaft, 89 Jahresversammlung, in St. Gallen, 1907, p. 176.

Cronartium ribicola causes the leaves of *Pinus strobus* to grow shorter and broader than normally; Klebahn believes it an undoubted return to the juvenile form.

1907. Jaap, Otto. Mykologisches aus dem Rhöngebirge. Allgemeine Botanische Zeitschrift, vol. 13, p. 187.

Note of occurrence of *Cronartium ribicola* in Germany.

1907. Juel, O. Öfversikt af våra värdväxlande rostsvampar. Svensk Botanisk Tidskrift, vol. 1, p. 247.

Cronartium ribicola is mentioned as occurring in Sweden.

1907. Kornauth, K. K. K. Landwirtschaftlich-Bakteriologische und Pflanzenschutzstation. Zeitschrift für das Landwirtschaftliche Versuchswesen in Oesterreich, vol. 10, pp. 208, 209.

Cronartium ribicola is mentioned as occurring on white pine in Bohemia and the Tyrol.

1907. Liro, J. I. Kulturversuche mit finnischen Rostpilzen. Acta Societatis pro Fauna et Flora Fennica, vol. 29, no. 7, p. 22.

Liro proved that *Peridermium pini* has no connection with *Cronartium ribicola* by inoculations on leaves of *Ribes grossularia*, *R. nigrum*, and *R. rubrum* with spores of the former without infection occurring.

1907. Marchal, Émile. Rapport sur les observations effectuées par le Service Phytopathologique de l'Institut Agricole de l'Etat en 1906. Bulletin de l'Agriculture, vol. 23, p. 40.

Note of occurrence of *Cronartium ribicola* in Belgium in 1906.

1907. Neger, F. W. Die Nadelhölzer, pp. 110, 111.

Neger says the white-pine blister rust is the most destructive disease of *Pinus strobus* in Europe.

1907. Neger, F. W., and Büttner, G. Ueber Erfahrungen mit der Kultur fremdländischer Koniferen im akademischen Forstgarten zu Tharandt. Naturwissenschaftliche Zeitschrift für Land- und Forstwirtschaft, vol. 5, p. 208.

Cronartium ribicola is mentioned as occurring on *Pinus monticola.*

1907. Pechon, L. Principales maladies des arbres et des peuplements forestiers. Bulletin de la Société Centrale Forestière de Belgique, 14, pp. 329–330.

A good description of *Cronartium ribicola* upon older trees of white pine; occurs seriously on trees in the forests in Ardennes, France; gives methods of combating.

1907. Potebnia, A. Verzeichnis der in Mittel-Russland (Gouv. Kursk und Charkow) gesammelten Pilze. Annales Mycologici, vol. 5, p. 12.

Note of occurrence of *Cronartium ribicola* in Russia.

1907. Ritzema Bos, J., Staes, G., and Hall, C. J. J. van. Phytopathologische Beobachtungen aus Holland. Zeitschrift für Pflanzenkrankheiten, vol. 16, p. 145.

Note of occurrence of *Cronartium ribicola* on *Pinus strobus* in Holland.

1907. Stewart, F. C. An outbreak of the European currant rust, Cronartium ribicola Dietr. Science, n. s., vol. 25, p. 262.

A brief note on the discovery of this fungus in America.

1908. (Anonymous.) Journal of the Board of Agriculture (London), vol. 15, p. 689.

Note of occurrence of *Cronartium ribicola* at Hailsham and Ipswich, England.

1908. Bubák, Franz. Die Pilze Böhmens, vol. 1, pp. 176–177. (Archiv für die Naturwirtschaftliche Landesdurchforschung von Böhmen, vol. 13, no. 5.)

Notes of occurrence of *Cronartium ribicola* in Bohemia.

1908. Clinton, G. P. Heterœcious rusts of Connecticut having a peridermium for their æcial stage. Report of Botanist, Connecticut Agricultural Experiment Station, 1907, p. 394.

Cronartium ribicola is liable to be introduced on white pine from Europe.

1908. Ducomet, V. Botanique agricole. Pathologie végétale, p. 173.

Bare mention of *Cronartium ribicola.*

1908. Hariot, Paul. Les Urédinées, p. 281.

Brief mention of *Cronartium ribicola.*

1908. Jaczewski, A. A. Yezhegodnik sviedienii o bolieznіakh i povrezhdeniiakh kulturnykh i dikorastushchykh poleznykh rastenii, vol. 3, pp. 142–143, 188. (In Russian.)

Cronartium ribicola is often found in the Government of St. Petersburg on *Ribes nigrum;* much *Pinus cembra* is present but no *P. strobus.* In the city of Kursk black currants near diseased white pine were worse affected than those farther away. Reported from Government of Voronej on *Ribes rubrum* as well as *R. nigrum;* from Livland, and from city of Tomsk, Siberia.

1908. Klebahn, H. Kulturversuche mit Rostpilzen, XIII. Zeitschrift für Pflanzenkrankheiten, vol. 17, pp. 148–149.

Made inoculations with *Peridermium pini* upon Ribes without result.

1908. Köck, Gustav. Krankheiten und Schädlinge des Beerenobstes und ihre Bekämpfung. Mitteilungen der K. K. Landw. Bakter. und Pflanzenschutzstation in Wien, p. 9. (Separate from Blätter für Obst-, Wein- und Gartenbau, no. 136.)

Köck says that the currant felt rust occurs frequently and cautions against growing the two hosts together.

1908 *b*. Köck, Gustav. Die häufigsten pilzlichen Krankheiten unserer wichtigsten Nadelhölzer und ihre Bekämpfung. Mitteilungen der K. K. Landw. Bakter. und Pflanzenschutzstation in Wein, pp. 15–16. (Separate from Landes-Amtsblatt des Herzogtumes Österreich unter der Ems, June 15 and July 1.)

General statement of hosts of *Cronartium ribicola;* says it is very destructive and recommends removing and burning the affected parts and plants and the separation of the two hosts.

1908. Laubert, R. Ueber den Wirtswechsel des Blasenrostes der Kiefern (Peridermium pini). Deutsche Landwirtschaftliche Presse, vol. 35, pp. 596–597.

Brief statement of heterœcism of *Cronartium ribicola.*

1908. Neger, F. W. Ein Infektionsversuch mit Peridermium strobi von Pinus monticola. Naturwissenschaftliche Zeitschrift für Land- und Forstwirtschaft, vol. 6, p. 605.

Planted several species of Ribes near trees of *Pinus monticola* which were affected with the white-pine blister rust; only *Ribes sanguineum* became diseased.

1908. Palm, Björn. Till kännedomen om Stockholmstraktens Svampflora. Svensk Botanisk Tidskrift, vol. 2, p. 39.

Note of occurrence of *Cronartium ribicola* in Sweden.

1908. Peck, Charles H. Report, New York State Botanist, 1907, p. 20.

Note on Stewart's discovery of *Cronartium ribicola* in the State of New York.

1908. Sorauer, P. Handbuch der Pflanzenkrankheiten, vol. 2, p. 349.

A general account of the life history of *Cronartium ribicola.*

1908. Turconi, M. Intorno alla micologia Lombarda. Memoria Prima. Atti dell' Istituto Botanico della R. Università di Pavia, vol. 12, p. 118.

Note of occurrence of *Cronartium ribicola* in Italy.

1909. (Anonymous.) Canadian Forestry Journal, vol. 5, pp. 165–166.

Brief mention of discovery of *Peridermium strobi* in New York.

1909. (Anonymous.) Forestry Quarterly, vol. 7, p. 487.

Mentions Von Reitzenstein's statement that the nurseries of Halstenbek are now free from the white-pine blister rust.

1909. Atwood, G. G. Emergency bulletin on the blister rust of pines and the European currant rust. Hort. Bulletin 2, Dept. of Agriculture, State of New York, pp. 1–20.

A good popular account of the discovery of *Cronartium ribicola* on white pines in America in 1909; the life history of the fungus, description of the disease, measures taken to eradicate it, and a partial reprint of Stewart's bulletin (1906).

1909. Beissner, L. Handbuch der Nadelholzkunde, pp. 349, 353, 693 (2d ed.).

States that *Pinus strobus* and *P. monticola* suffer from the blister rust, the treatment of which must be immediately considered upon its appearance.

1909. Curtis, Ellicott D. Rejoinder to D. Hill on cost of evergreen seedlings. Forestry Quarterly, vol. 7, p. 254.

Says the white-pine blister rust is liable to reduce the amount of planting that will be done in the next few years.

1909. Delacroix, G., and Maublanc, A. Maladies des plantes cultivées, p. 185.

A brief statement of heterœcism of *Cronartium ribicola.*

1909. Duggar, B. M. Fungous diseases of plants, pp. 433–435.

A short account of the white-pine blister rust and the disease caused by it.

1909. Fisher, W. R. Experimental plantations at Cooper's Hill. Quarterly Journal of Forestry, vol. 3, p. 229.

No white-pine blister rust is found at Cooper's Hill, but it is exterminating white pine at Woburn and is very prevalent in the Windsor Forest.

1909. Griffon, E., and Maublanc, A. Notes de pathologie végétale (mildiou, black-rot, rouilles). Bulletin de la Société Mycologique de France, vol. 25, p. 144.

Says *Peridermium strobi* occurs in a nursery at Paris; also mentions its occurrence destructively in the Forest of Fontenoy.

1909. Kirchner, O., and Boltshauser, H. Atlas der Krankheiten und Beschädigungen unserer landwirtschaftlichen Kulturpflanzen, ser. 6, pl. 15.

A colored plate showing *Cronartium ribicola* on *Pinus strobus.*

1909. Klugkist, C. E. Zur Kenntnis der Schmarotzerpilze Nordwestdeutschlands. Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen, vol. 19, p. 396.

Note of occurrence of *Cronartium ribicola* in Germany.

1909. ——— Vierter Beitrag: Flora von Celle. Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen, vol. 19, pp. 407, 409.

Notes of occurrence of *Cronartium ribicola* in both stages in Hanover, Germany.

1909. Köhler. Dendrologische Mitteilungen. Mitteilungen der Deutschen Dendrologischen Gesellschaft, 1892–1898, p. 277.

The white-pine blister rust is killing the white pines of the Altenburg park; sprinkled with a strong stream of cold water the forming blisters disappeared.

1909. Pettis, C. R. The white-pine blister rust. Forestry Quarterly, vol. 7, pp. 231–235.

A very good short statement concerning the white-pine blister rust and the procedure adopted in New York in eradicating it.

1909. Reitzenstein, von. Die Baumschulen von H. H. Pein in Halstenbek (Holstein). Forstwissenschaftliches Centralblatt, vol. 31, p. 36.

Von Reitzenstein says that a few years ago the white-pine blister rust caused discrimination against white-pine seedlings raised in Halstenbek, but that it is now entirely eradicated.

1909. Rikli, M. Die Arve in der Schweiz. Neue Denkschriften der Schweizerischen Naturforschenden Gesellschaft, vol. 44, pp. 429–430.

Contains a statement of what other writers have said concerning the occurrence of *Cronartium ribicola* in Switzerland on *Pinus cembra.*

1909. Schelle, E. Die winterharten Nadelhölzer Mitteleuropas, pp. 25–26.

Gives methods of combating the white-pine blister rust.

1909. Schenck, C. A. Forest protection, p. 119.

A good brief statement concerning the white-pine blister rust.

1909. Somerville, W. Peridermium strobi, the blister of Weymouth pine. Quarterly Journal of Forestry, vol. 3, pp. 232–236.

The white pine is being exterminated in Britain and *Pinus monticola* is seriously attacked; Canada and the United States should prohibit the importation of foreign stock of five-leaved pines and Ribes; the damage will be appalling if it becomes established in America and causes as much damage as it is now doing in England.

1909 *a*. Spaulding, Perley. European currant rust on the white pine in America. Circular 38, Bureau of Plant Industry, U. S. Dept. of Agriculture, pp. 1–4.

A short account of the importation of the white-pine blister rust into America in 1909, its record in Europe, and methods of eradication.

1909 *b*. ——— Peridermium strobi Klebahn in America. Science, n. s., vol. 30, pp. 200–201.

Similar to the above.

1909. Zon, Raphael. Forestry Quarterly, vol. 7, p. 236.

Notes on the history of *Cronartium ribicola* in Europe.

1910. (Anonymous.) Biennial report of the New Hampshire Forestry Commission for the years 1909–1910, pp. 82–83.

A statement of the occurrence of the blister rust in this country and in New Hampshire.

1910. (Anonymous.) Science, n. s., vol. 31, p. 699.

Resolutions by the American Phytopathological Society; views with alarm the recent introduction of *Chrysophlyctis endobiotica* and *Peridermium strobi* into America, deplores absence of regulation of importations, regards situation as serious, and pledges support to legislation for control of importation.

1910. (Anonymous.) Canadian customs regulations, May 11, 1910.

Places *Peridermium strobi* among the proscribed fungi under the Destructive Insect and Pest Act.

1910. (Anonymous.) Peridermium strobi. Quarterly Journal of Forestry, vol. 4, p. 140.

Notes the discovery of *Peridermium strobi* in the United States, and states that it "must be regarded as most serious, and it is to be hoped that the steps being taken to exterminate it will prove successful.

1910. Jaap, Otto. Ein kleiner Beitrag zur Pilzflora der Eifel. Annales Mycologici, vol. 8, p. 146.

1910. Peck, Charles H. Bulletin 139, New York State Museum, p. 27.

Cronartium ribicola is mentioned as being destructive to white pine.

1910. Pettis, C. R. The European blister rust. Report, New York Forest, Fish, and Game Commission, vol. 15, pp. 148–164 and pl. 3.

An account of the discovery of the white-pine blister rust in New York and adjacent States, action taken by the meeting of foresters concerned, rules of procedure for the New York inspectors, and a brief account of the life history of the fungus.

1910. Schander, R. Bericht über das Auftreten von Krankheiten und tierischen Schädlingen an Kulturpflanzen in den Provinzen Posen und Westpreussen im Jahre 1908. Mitteilungen des Kaiser Wilhelms Institutes für Landwirtschaft in Bromberg, vol. 2, p. 134.

Schander found the white-pine blister rust in 1908.

1910. Selby, A. D. A brief handbook of the diseases of cultivated plants in Ohio. Bulletin 214, Ohio Agricultural Experiment Station, pp. 396, 429.

Brief mention of this disease in the United States.

1910 *a*. Spaulding, Perley. Peridermium strobi, an importation from Europe. Science, n. s., vol. 31, pp. 78–79.

A brief summary of a paper presented before the Botanical Society of Washington.

1910 *b*. ——— European currant rust on white pine in America. Science, n. s., vol. 31, pp. 756–757.

A brief summary of a paper presented at the 1909 meeting of the American Association for the Advancement of Science.

1910. Stevens, F. L., and Hall, J. G. Diseases of economic plants, p. 155.

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DESCRIPTION OF PLATES.

PLATE I. (*Frontispiece.*) *Cronartium ribicola* on *Pinus strobus* and Ribes. *A.*—A 4-year-old white-pine tree diseased with blister rust. Note the slight swelling of the stem in the area bearing the yellow spore pustules. *B.*—Leaf of *Ribes aureum* bearing many pustules of uredospores. *C.*—Enlarged detail of uredo pustules. *D.*—Leaf of *Ribes americanum* with a number of the hairlike growths of the teleutospore stage. These spores are capable of infecting pine, while the first two forms can not, but can infect the leaves of Ribes.

PLATE II. Fig. 1.—A stunted 4-year-old white-pine tree, showing cracked bark caused by bearing fruiting bodies the previous season. The stem is thickened somewhat from near the soil to the branches. Fig. 2.—A stunted 4-year-old white-pine tree bearing fruiting bodies on its stem. Note the short growth in top, not more than half the normal growth at this stage. The stem is thickened from the first branch to the top.

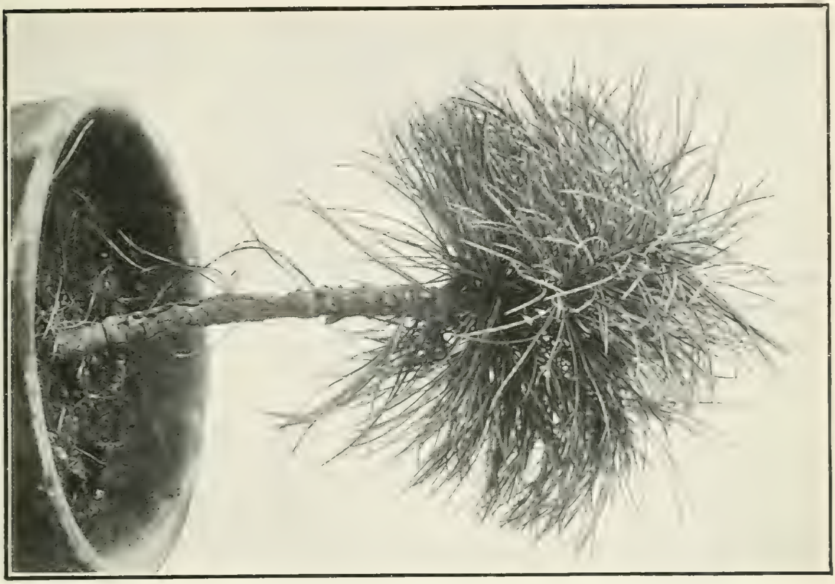

FIG. 1.—A STUNTED WHITE PINE SHOWING CRACKED BARK.

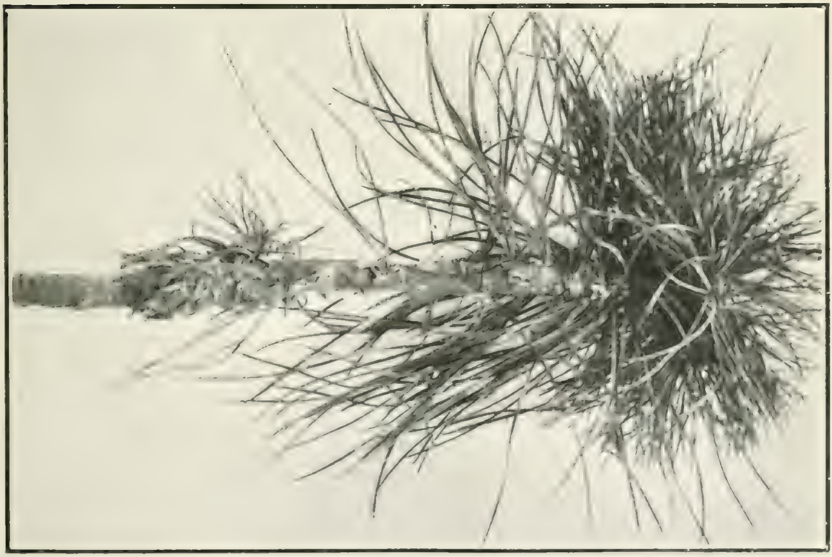

FIG. 2.—A STUNTED WHITE PINE BEARING FRUITING BODIES.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 207.

B. T. GALLOWAY, *Chief of Bureau.*

SEEDS AND PLANTS IMPORTED

DURING THE PERIOD FROM JANUARY 1 TO MARCH 31, 1910:

INVENTORY No. 22; Nos. 26471 to 27480.

Issued May 4, 1911.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., December 28, 1910.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 207, of the series of this Bureau, the accompanying manuscript, entitled "Seeds and Plants Imported during the Period from January 1 to March 31, 1910: Inventory No. 22; Nos. 26471 to 27480."

This manuscript has been submitted by the Agricultural Explorer in Charge of Foreign Seed and Plant Introduction, with a view to publication.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—637.

SEEDS AND PLANTS IMPORTED DURING THE PERIOD FROM JANUARY 1 TO MARCH 31, 1910: INVENTORY NO. 22; NOS. 26471 TO 27480.

INTRODUCTORY STATEMENT.

This inventory, No. 22, is a record of seed and plant introductions received by the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry from January 1 to March 31, 1910. It contains 1,010 introductions, an increase of 588 over those of the quarter ended December 31, 1909.

Some of these introductions merit especial mention in this introductory statement. In Nos. 26471 to 26475 we have several interesting introductions from Kashmir, India, embracing a cherry (No. 26471), a peach (No. 26472), an apricot (No. 26473), a pear (No. 26474), and an apple (No. 26475). Five hardy drought-resistant Chinese pears come to us from Manchuria under Nos. 26485 to 26489. Another introduction of interest is a dry-land shrub related to Citrus (*Limonia acidissima*, No. 26496) from Kirkee, India. This will be especially valuable for breeding purposes. No. 26511 is a wild pomegranate (*Punica protopunica*) from the island of Socotra, probably a prototype of the cultivated pomegranate. This was introduced for breeding purposes and as a suitable stock for the southwest sections of the country on which to graft the improved form. The first generation of potatoes from seed introduced from Chile (Nos. 26517 to 26535); a number of interesting species of wild clovers from the mountains of Turkey, for testing and breeding purposes (Nos. 26574 to 26578); a wild medicago (No. 26590) from the arid mountain regions of Algeria; seeds of the native hardy Manchurian pear (No. 26591) are all worthy of attention.

An introduction of considerable commercial value is the Black Monukka seedless grape of India. This was found by the writer in the greenhouses of the Royal Horticultural Society at Wisley, England, and sent in at his request by Rev. W. Wilks, secretary of the society. This adds a dark-purple seedless grape to the seedless grapes already in cultivation in America. A number of varieties of soy beans from Manchuria (Nos. 26643 to 26646) and two species of dry-land alfalfa from the Crimea (Nos. 26666 and 26667); *Medicago orbicularis* (No. 26673) from Balaklava, Crimea, an annual form found growing on dry, hilly slopes and on sterile, stony plains, and much relished by sheep and horses, will be of interest to forage-crop experimenters. A new form of *Malus baccata*, from Nertchinsk, Siberia, introduced under No. 26681, is being used around St. Petersburg for hybridizing with *M. prunifolia* in an endeavor to obtain a hardier race of apples, and a new crab apple (No. 26682) said to be a better keeper than the American crab, the result of a cross between *M. baccata* and *M. prunifolia*, will attract the attention of the apple breeder.

The introductions from Nos. 26689 to 26730, inclusive, comprise 42 selected varieties of avocados from seedlings grown in Florida and imported from Cuba and Costa Rica. There are many fine types among these introductions that will be very valuable to growers of this new fruit in Florida and probably in southern California. Nine varieties of cherimoya (Nos. 26731 to 26739) have been selected from a number of seedlings grown in Florida, for their superior qualities. An interesting relative of our wild rice is introduced under No. 26760, *Zizania latifolia*. This wild rice is a native of and is cultivated extensively in China and Japan for its edible shoots and for a fungous growth that develops on the inflorescence which is said to be edible when in a young state. *Pyrus salicifolia* (No. 26763) is a wild pear from the hills near Sebastopol, Russia, where it is subjected to extremely dry conditions, and no doubt will prove valuable as a pear stock in our semiarid regions. Another introduction that will be valuable for the same regions, coming from the neighborhood of Sebastopol, is *Crataegus orientalis* (No. 26765). This is recommended as a stock for pears and for uses as an ornamental plant. In Nos. 26801 to 26811 is a very hardy race of olives that has withstood a temperature of about $-2°$ F. without injury. These olives may be valuable for sections of Texas and California where heavy frosts prevail during the winter months.

No. 27310, *Amygdalus davidiana*, is another importation of this valuable plant that may mean much to the peach growers of the colder and semiarid sections of our country. A report comes to us from the Upper Mississippi Valley Plant Introduction Garden that young trees of this peach passed through the winter of 1909–10 without the slightest injury, while such well-known varieties as Chihli and Champion were more or less seriously injured. This wild peach promises to be very valuable for breeding work. Nos. 27362 and 27363 are Ohanez grapes (*Vitis vinifera*), famed for the extraordinary carrying and keeping qualities of their fruit. The fruits ripen late and are therefore adapted only to the warmer grape-growing sections.

Mr. W. F. Wight, Mr. H. C. Skeels, and Miss Mary A. Austin are responsible for the preparation of this inventory.

David Fairchild,
Agricultural Explorer in Charge

Office of Foreign Seed and Plant Introduction,
Washington, D. C., November 19, 1910.

INVENTORY.

26471 to 26475.

From Kashmir, India. Presented by Mr. J. Mollison, Inspector General of Agriculture in India, Nagpur, Central Provinces. Received January 3, 1910.

Seeds of the following wild species; notes by Mr. Mollison:

26471. Prunus cerasus L. **Cherry.**

"This tree bears fruit when 5 years old and 10 feet high."

26472 to 26474. "These trees bear fruit when 4 years old and 15 feet high."

26472. Amygdalus persica L. **Peach.**

26473. Prunus armeniaca L. **Apricot.**

26474. Pyrus communis L. **Pear.**

26475. Malus sylvestris Mill. **Apple.**

"This tree bears fruit when 6 years old and 20 feet high."

"These seeds are sown in October or in March. If sown in October, the seedling comes out in March, but if sown in March, it comes out in April."

26476. Pennisetum pedicellatum Trin.

From Senegal, West Africa. Presented by Dr. L. Trabut, Government Botanic Gardens, Algiers, Algeria. Received January 4, 1910.

"Variety *occidentale*."

Distribution.—Rajputana and Banda, in India, and in tropical Africa.

26477 to 26484. Phoenix dactylifera L. **Date.**

From Tripoli-in-Barbary, North Africa. Procured by the American vice consul, at the request of Mr. William Coffin, formerly American consul. Received December 15, 1909.

Seeds of the following:

26477. *Bayoudi.*
26478. *Brunsi.*
26479. *Cabouni.*
26480. *Hadruri.*
26481. *Hallaoui.*
26482. *Hammuri.*
26483. *Hurra.*
26484. *Limsi.*

26485 to 26489. Pyrus spp.

From Manchuria. Presented by Mr. Edward C. Parker, agriculturist, Bureau of Agriculture, Industry and Commerce, Mukden. Received January 3 and 4, 1910.

Cuttings of the following; descriptive notes by Mr. Parker:

"All these pears are very hardy and resistant to droughts and high, drying winds. They are cultivated by the Chinese in many places among the hills of southwestern

26485 to 26489—Continued.

Manchuria, as far north as 43° to 44° north latitude. Their power to resist drying winds and drought is the most notable character they possess. The fruits are all hard, maturing late and keeping all winter. The quality of the fruit is not anywhere near as good as the American *Bartlett* or *Anjou;* it is quite edible, however, and might be valuable for culture in such regions as North and South Dakota, where hot winds, short periods of drought, and cold winters form a climate very similar to the native habitat of these trees; they might also be used for grafting stocks."

26485. "(No. 6.) Chinese name *Ya li.* A very popular pear in Chinese markets; of medium size, shaped like the American *Bartlett* and of a yellowish-white color; flesh rather coarse and not highly flavored, keeps all winter. Kwangning is the oldest and best known producing center of this pear."

26486. "(No. 7.) Chinese name *Hung li.* Fruit is small, reddish yellow in color, and in shape similar to *Whitney* crab apples. Flesh of fruit coarse and not highly flavored."

26487. "(No. 8.) Chinese name *Chang pao li.* Fruit is yellowish white in color; shape long and oval; flesh of fruit coarse and not highly flavored."

26488. "(No. 9.) Chinese name *Yuen pao li.* Fruit is yellowish white in color, shape and size of a small round apple, flesh coarse and not highly flavored."

26489. (No name or description received with this lot of cuttings.)

26490 to 26494.

From Settsu, near Kobe, Japan. Procured by Mr. Albert J. Perkins, from the Japan Nursery Company. Received January 3, 1910.

Cuttings of the following:

26490 and **26491.** DIOSPYROS sp. **Persimmon.**

26490. *Hachiya.* **26491.** *Fuyu kaki.*

26492. PAPYRIUS sp.

Kogo.

26493. PAPYRIUS PAPYRIFERA (L.) Kuntze.

26494. CITRUS AURANTIUM L. **Orange.**

"*Natsu-mikan.*" See No. 22670 for description.

26496. LIMONIA ACIDISSIMA L.

From Kirkee, India. Presented by Mr. G. A. Gammie, Imperial Cotton Specialist. Received January 5, 1910.

"This is a shrub or small tree growing in dry situations in India, sometimes at a height of as much as 4,000 feet. The fruits are very small, but are occasionally used as a condiment by the natives. The wood is hard and suitable for parts of machinery where great strength and toughness are required. This plant belongs to the orange family and is introduced primarily in connection with the experiments now in progress in the breeding of new types of citrus fruits and stocks for the same." (*W. T. Swingle.*) (Seed.)

Distribution.—On dry hills in the northwestern Himalayas, ascending to 4,000 feet, on the Monghyr Hills in Behar, in Assam, and from the Bombay Ghats and Coromandel southward in the western peninsula of India. It occurs also in the Province of Yunnan, southwestern China.

26499 and 26500.

From Kavali, Nellore district, India. Presented by Rev. E. Bullard. Received January 10, 1910.

Seeds of the following; notes by Rev. E. Bullard:

26499. Erythrina indica Lam.

"A useful hedge tree used commonly here around betel-leaf gardens. It is leguminous, does not have very spreading limbs, grows rapidly in almost any soil, and attains a height of 30 or 40 feet. It can be transplanted and propagated by cuttings of any size; these require watering for a time until well rooted. It is planted close together as a hedge, a foot or less apart, at first, and the spaces between are filled in with wild sugar cane. The leaf of the *Badidi* is excellent fodder for cattle, sheep, and goats—probably for any animals. The wood is also used in making some ordinary implements. By being cut low it forms an excellent hedge for keeping out animals. The Telugu name is *Badidi* or *Badishe.*"

Distribution.—Throughout India and the Polynesian Islands; often cultivated.

26500. Melia azedarach L.

"A tree called *Turaka vyapa* in Telugu, or a variety of the margosa; it is much inferior, however, to the usual margosa, though useful as a quick-growing tree. Its seed contains an oil used for medicinal purposes."

26501. Rheum nobile Hook. f. and Thoms.

From Sikkim, E. Himalaya, India. Presented by Capt. A. T. Gage, superintendent, Royal Botanic Garden, Sibpur, near Calcutta, India. Received January 10, 1910.

"The individual plants of *Rheum nobile* are upward of a yard high, and form conical towers of the most delicate, straw-colored, shining, semitransparent, concave, imbricating bracts, the upper of which have pink edges, the large bright, glossy, shining, green radical leaves, with red petioles and nerves, forming a broad base to the whole. On turning up the bracts, the beautiful membranous, fragile, pink stipules are seen, like red silver-paper, and within these, again, the short-branched panicles of insignificant green flowers.—The stems of this plant (called '*Chuka*' by the inhabitants) are pleasantly acid, and much eaten.—The seeds should be planted in peat soil and rockwork, and kept very cool and damp." (J. D. Hooker. Illustrations of Himalayan Plants, 1855, pl. 19.)

Distribution.—The alpine slopes of the Himalaya Mountains, at an elevation of 13,000 to 15,000 feet, in the Province of Sikkim, northeastern India.

26502 to 26504.

From Chinese Turkestan. Presented by Mr. E. Cotes, Simla, India. Received November 17, 1909.

Seeds of the following:

26502. Prunus armeniaca L. Apricot.

26503. Amygdalus persica L. Peach.

26504. Citrullus vulgaris Schrad. Watermelon.

26505 and 26506. Sesamum orientale L. Sesame.

From China. Presented by Rev. J. M. W. Farnham, Shanghai, China. Received January 5, 1910.

Seeds of the following:

26505. Black seeded. **26506.** White seeded.

26509 and 26510. MANGIFERA INDICA L. **Mango.**

From Kingston, Jamaica. Presented by Mr. Aston W. Gardner, Tangley Fruit Company. Received January 14, 1910.

26509. *Maharajah.* "Cuttings from a tree grown in my orchard. This special fruit has realized very high prices in London and New York." (*Gardner.*)

26510. *Mangalore.* (Cuttings.)

26511. PUNICA PROTOPUNICA Balf. f.

From Edinburgh, Scotland. Presented by Dr. Isaac Bayley Balfour, director, Royal Botanic Garden. Received January 17, 1910.

"This is a small tree which grows in abundance over the plateau sloping southward from the Haghier peaks. In general habit it is not unlike the pomegranate, but its leaves are larger and coarser and it lacks the delicate character of the foliage of that species. The flowers, too, are somewhat smaller and their turbinate base is more angular; the fruit is very much smaller in size." (*Balfour, Botany of Socotra, 1888, Pl. 25, p. 96.*)

"It was considered desirable to introduce this plant, which, aside from the ordinary pomegranate, is the only species of the genus *Punica* and is possibly the ancestral form of the cultivated pomegranate, in order to test its value as a drought-resistant stock upon which to graft pomegranates in the hottest part of the Southwest." (*T. H. Kearney.*) (Cuttings.)

Distribution.—Known only from the island of Socotra, on the east coast of Africa.

26517 to 26535. SOLANUM spp. **Potato.**

Grown at Arlington Experimental Farm, Virginia, under the supervision of Mr. W. V. Shear, Office of the Horticulturist. Turned over to this office for distribution January, 1910.

Tubers of Chilean potatoes, first generation grown from seed as follows; notes by Mr. Shear:

26517. Grown from S. P. I. No. 23167. "Small tubers, round to oblong; skin smooth; eyes few and shallow; color yellowish white."

26518. Grown from S. P. I. No. 23173. "Elongated, cylindrical, somewhat flattened, uniform tubers; eyes numerous, shallow; skin smooth, flesh-colored; size variable, small to medium."

26519. Grown from S. P. I. No. 23184. "Tubers roundish, flattened at the ends, uniform; size small; skin smooth; eyes few, medium in depth; color violet."

26520. Grown from S. P. I. No. 23191. "Small to medium-sized tubers; shape round to oblong, uneven; eyes numerous and deep; color purple."

26521 to 26524. Grown from S. P. I. No. 23168.

26521. "Small tubers, ovoid, flattened; eyes medium depth; color flesh."

26522. "Small tubers, oblong, slightly flattened; eyes many and deep; color variable, yellowish to violet."

26523. "Tubers oblong, cylindrical, variable; eyes medium depth, uniform; color yellowish splotched with violet."

26524. "Tubers small, oblong, pointed at bud end; shape uniform, slightly flattened; eyes shallow; color yellowish with slight tinge of violet."

26517 to 26535—Continued.

26525 to 26531. Grown from S. P. I. No. 23178.

26525. "Tubers medium small, round, uneven; eyes deep, numerous; color deep violet."

26526. "Tubers ½ to 2 ounces in weight; shape round to oblong, flattened, variable, uneven; eyes many, deep; color varying from flesh to light violet."

26527. "Tubers ovoid, uneven, smooth; eyes numerous, deep; color purple, yellowish around eyes."

26528. "Tubers round to ovoid, variable and uneven; skin rough; eyes numerous, medium; color yellowish white."

26529. "Tubers large, elongated, cylindrical, uneven; eyes many and deep; color yellowish with small patches of violet."

26530. "Tubers small to medium; shape round to ovoid; uneven, knobby; eyes numerous, shallow; color mottled violet and yellow."

26531. "Medium-small tubers; shape ovoid, flattened, uneven; eyes numerous, deep; skin rough; color yellowish, mottled with violet."

26532 and 26533. Grown from S. P. I. No. 23185.

26532. "Tubers small to medium; oblong, variable; eyes numerous and variable; color violet."

26533. "Tubers round, inclined to be flattened at each end; uneven; eyes few, variable."

26534 and 26535. Grown from S. P. I. No. 23194.

26534. "Tubers small, ovoid to oblong, pointed at bud end, uniform; smooth; eyes numerous, medium depth; flesh-colored."

26535. "Tubers small; shape variable, ovoid, flattened; skin smooth; eyes few, shallow; light yellow mottled with violet."

26536. MEDICAGO SATIVA L. **Alfalfa.**

Presented by Mr. D. S. Elder, El Centro, Imperial Co., Cal., through Mr. Charles J. Brand. Received December, 1909.

"This alfalfa is ordinary American alfalfa and was grown 3 miles west of Brawley in the Imperial Valley of California from seed secured by Mr. Elder from his brother in Wyoming. It was grown in a loose, sandy soil on a field which was without water from April, 1906, until May, 1908. The ditch which supplied this field was dry during this period on account of the Colorado River breaking through its banks and flowing into the Salton Sea. No records of rainfall are available for Brawley, but it is estimated that the precipitation for the two years was about 2 inches each. Part of this alfalfa was cut and part pastured during the time that it was without water. The present sample should be of use in selections for drought resistance." (*Brand.*)

26537 to 26539. MEDICAGO SATIVA L. **Alfalfa.**

From Sacaton, Ariz. Grown under the supervision of Mr. Charles J. Brand on the Testing and Demonstration Garden in cooperation with the Office of Indian Affairs and received through Mr. William L. Flanery, January, 1910.

Seeds of the following; notes by Mr. Brand:

26537. "Mixed seed from a plat in which over 100 regional strains of alfalfa are being grown, intended for use in mass selection work."

26538. "First crop of Peruvian alfalfa, grown in hills 2½ feet apart, rows 3 feet apart. It yielded at the rate of about 6 bushels per acre. The seed plat received only one irrigation up to the time of cutting the first crop."

26537 to 26539—Continued.

26539. "Second seed crop of Peruvian alfalfa from the same plat that produced No. 26538. Both of these lots of seed are second-generation progeny of S. P. I. No. 9303. The first-generation seed was produced at Yuma, Ariz., from the original lot."

26540. MEDICAGO SATIVA L. **Alfalfa.**

From Tappen, N. Dak. Grown by Mr. W. H. Niles in cooperative experiments with Mr. Charles J. Brand. Received January, 1910.

Grimm. "This seed was produced in 1909 from an acre plat seeded in comparison with 15 others at Tappen, N. Dak., in the spring of 1905. To date it has proven the hardiest variety in the experiment, which includes seed from a number of points in the United States, Germany, France, and Russia." (*Brand.*)

26543. AMYGDALUS COMMUNIS L. **Almond.**

From mountainous regions of Algeria, height about 3,300 feet. Presented by Dr. L. Trabut, Algiers, Algeria. Received January 18, 1910.

"A wild form of tolerably large size, robust, and very resistant to drought. Would be a good stock." (*Trabut.*)

26561. BAUHINIA MONANDRA Kurz. (?)

From Port Louis, Mauritius. Presented by Mr. G. Regnard. Received January 18, 1910.

26562. CYDONIA sp. **Quince.**

From Shanghai, China. Presented by Rev. J. M. W. Farnham. Received January 21, 1910.

"These quinces grow very large, but are coarser and harder than American varieties. The one from which part of these seeds were taken was 12 inches in circumference and about 5 inches long." (*Farnham.*)

26563 and 26564. BRASSICA OLERACEA CAPITATA L. **Cabbage.**

From Manchuria. Presented by Mr. A. A. Williamson, American vice and deputy consul, Dalny, Manchuria. Received January 18, 1910.

Seeds of the following:

26563. From Kinchow.

26564. From Chefoo.

26566. VITIS VINIFERA L. **Grape.**

From Besni, in the Deyarbekir Valley, Turkey. Procured by Mr. Wm. W. Masterson, American consul, Mamuretul-Aziz (Harput), Turkey. Received January 20, 1910.

Cuttings of the following. The white and the black variety are contained in this shipment, but this was not learned until some time after it had been received:

Besni. "This grape is long in shape, similar to the *Thompson Seedless*, and from what I have heard, larger than *Muscat*, but not having as many seeds, only one or two. When it is dried, it is claimed it has an oblong shape and has a clearer and lighter color than a *Muscat.*" (*Extract from letter of Mr. Z. J. Josephian, which was inclosed in one from Miss Dorothy Farmer, Oakland, Cal., received February 26, 1908.*)

"I have never tasted such grapes anywhere as I have here, and the raisins made from these particular grapes (*Besni*) are of a wonderfully fine flavor and very large, and I think if such vines could be cultivated in America, it would prove a wonderful addition to our grape industry." (*Masterson.*)

26567 and 26568.

From Japan. Purchased from the Yokohama Nursery Company, Yokohama, Japan. Received January 18, 19, and 20, 1910.

Seeds of the following:

26567. Citrus trifoliata L.

From Kiushiu. "Up to Fukuoka this tree is cultivated, possibly as far north as Tsushima, though we are not certain. Prof. Ikeda says its north limit extends to 37° north latitude. The fruits from Kiushiu are larger than those produced here (Yokohama)." (*Yokohama Nursery Company.*)

26568. Citrus sp.

Yuzu. "Orange grafted on this stock is said to be a little more sour than when grafted on *Citrus trifoliata.*" (*Yokohama Nursery Company.*)

"*Yuzu* is a large evergreen tree bearing round, medium-sized fruit, which is very acid, and has a coarse, thick rind. The fruit is used in Japan in place of the lemon, which is used in this country. The pulp cells are 12 or 13 in number, having 2 or 3 seeds in each. This *Yuzu* is so hardy that the bearing fruit can be seen when the ground is covered with snow more than 2 feet deep. In some sections of Japan the *Yuzu* is considered better than *Citrus trifoliata,* as trees grafted on it grow better and live longer than when grafted on *Citrus trifoliata.* When kumquats are grafted on *Yuzu* they weigh more than they do when grafted on *Citrus trifoliata* and have a smoother and more reddish-colored rind." (*Extract from a letter of Mr. Kizano contained in a letter from Mr. Walter T. Swingle, dated April 12, 1909.*)

26570 to 26579.

From the moister mountain regions of Asia Minor lying 25 to 30 miles from the Mediterranean, 3,000 to 4,000 feet above sea level, in lime and sandy soils. Presented by Mrs. F. A. Shepard, Adana, Turkey in Asia. Received January 3, 1910.

Seeds of the following:

26570. Avena sativa L. **Oat.**

26571. Pistacia terebinthus L.

Distribution.—The countries bordering on the Mediterranean Sea, from Bozen, in Austria, to Syria and Palestine.

26572. Lathyrus sp.

26573. Medicago orbicularis marginata (Willd.) Benth.

26574. Trifolium pilulare Boiss.

Distribution.—Stony and shady hills and mountain slopes in Asia Minor, extending from Smyrna through Mesopotamia and Syria.

26575. Trifolium sp.

26576. Trifolium sp.

26577. Trifolium sp.

26578. Trifolium sp.

26579. Vicia sp. (Several species mixed.)

26580. Vigna catjang (Burm.) Walp.

From Richmond, New South Wales, Australia. Presented by Mr. H. W. Potts, Hawkesburg Agricultural College. Received January 21, 1910.

Poona.

26581. ANDROPOGON CARICOSUS L.

From Antigua, Leeward Islands, British West Indies. Presented by Mr. S. Jackson, curator, Botanic Station. Received January 15, 1910.

"*Hay grass.* This is an East Indian grass, and in the West Indies, at present, is only found in Antigua. The history of its introduction is obscure. It is readily established, and once this is done takes possession of the land to the exclusion of other grasses. It grows on flat pasture areas, and when cut at the right time makes excellent hay." (*Extract from the Agricultural News, May 1, 1909, p. 131.*)

Distribution.—On the plains and low hills of India, from Scind to Burma; in the Province of Yunnan, China; and in Ceylon, Mauritius, and Timor.

26590. MEDICAGO SATIVA GAETULA Urb.

From Aures, Algeria. Procured by Mr. A. Clavé, director, Academy of Algiers, Oued-Zenati, Algeria. Received January 22, 1910.

"A wild form, said to occur in arid, exposed situations, and presumably very drought resistant." (*J. M. Westgate.*)

Distribution.—Slopes of the Atlas Mountains in the vicinities of Batna and Biskra, Algeria.

26591. PYRUS sp. **Pear.**

From Manchuria. Presented by Mr. Edward C. Parker, agriculturist, Bureau of Agriculture, Industry, and Commerce, Mukden. Received January 24, 1910.

"Seeds of the native Manchurian pear. I am of the opinion that the pear seedlings, when tested out in western nurseries or used for grafting purposes, will prove more valuable than the scions (S. P. I. Nos. 26485 to 26489)." (*Parker.*)

26592. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From Millard, Arkansas. Presented by Mr. J. L. Forlines. Received January 24, 1910.

"Similar to *Taylor Crowder* but with the micropylar end white. The original seed said to have been found in the craw of a wild goose." (*C. V. Piper.*)

26593 to 26596.

From Mamuretul-Aziz (Harput), Turkey. Presented by Mr. Wm. W. Masterson, American consul. Received January 21 and 22, 1910.

Seeds of the following; notes by Mr. Masterson:

26593. AMYGDALUS PERSICA L. **Peach.**

"This peach is rather large, has an excellent flavor, with the ordinary stone, but a peculiar thing is, it has a smooth, tough skin of a mottled red and green color, like an apple, but with the ordinary peach shape.

"One of the great drawbacks in handling peaches in America is the easily broken, fuzzy skin; in addition, this fuzz is exceedingly uncomfortable to the touch. This new peach is perfectly smooth, without the slightest sign of fuzz; it is of a size a little larger than the average shipping peach of America, grows on the same kind of a tree, and instead of its being a budded or hybrid fruit as I supposed, it is grown from the seed, and in this instance like produces like."

26594 and 26595. ELAEAGNUS ANGUSTIFOLIA L.

26594. Large fruited. **26595.** Small fruited.

"Trebizond date. This might be called a shrub. It grows in clusters to a height of some 8 or 10 feet and has a few rather sharp thorns on each limb.

26593 to 26596—Continued.

The leaf is rather long for its width, is shaped something like a willow leaf, and, like some willows, the leaf is silvery white underneath and a rich green on top. In the spring it has a wonderfully fragrant blossom, and in the autumn a fruit is matured that looks very much like the commercial date, although not so rich and sweet, but the poor of the country are sometimes reduced to eating it to a considerable extent. These bushes are particularly adapted to hot, dry climates where only occasionally a little water is given to them by irrigation. They are rapid growers, and are used in this country for hedges surrounding the fields for turning cattle. They are capable of standing a good, sharp freeze, as it frequently falls to 15° or 20° F. in this high altitude, and as this much cold has no effect on them they may be able to stand much colder weather.

"The idea I particularly have in mind in mentioning this plant is its superiority as a hedge over the Osage orange that is so commonly used in our country for the same purpose. They make a much more beautiful show than the Osage, grow very rapidly, are very bushy and thick, can be easily trimmed and kept in order, and as a novelty and something new would likely be much appreciated by our people. They grow very readily from cuttings or from seed and require but little attention."

26596. VICIA FABA L. **Horse bean.**

"This is called *Bakla* in Turkish. In addition to the beans the stalks are fed to cows and are said to be wonderful milk producers, and horsemen declare the stalks to be exceedingly cooling feed for horses during the summer. They are not as good as our best class of beans as a vegetable, but they have one merit—they are the first real garden vegetable in the spring after onions and lettuce, being a month earlier than the ordinary bunch beans. They are rather strong in flavor, and coarse, but among these people they are in great demand."

26598 to 26602.

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, government agrostologist and botanist, Transvaal Department of Agriculture. Received January 17 and 18, 1910.

Seeds of the following:

26598. INDIGOFERA sp.

26599. DIOSPYROS SENEGALENSIS Perrott.

See No. 25634 for previous introduction.

26600. PITTOSPORUM VIRIDIFLORUM Sims.

Distribution.—An erect shrub, found in the woods along the southeastern coast of Cape Colony, from the Knysna district to the vicinity of Umtata, in Kaffraria.

26601. ALOE TRANSVALENSIS Kuntze.

Distribution.—The vicinity of Pretoria, Transvaal.

26602. (Undetermined.) **"Rhodesian teak."**

"A typical tree of dryish regions." (*Davy.*)

26603. ANONA CHERIMOLA Miller. **Cherimoya.**

From Orange, Cal. Presented by Mr. C. P. Taft. Received January 27, 1910.

Golden Russet. "This variety originated or at least first fruited near Villa Park, Cal. I am told that the plant came from London, England. I do not think that they were budded trees, though they may have been. In form the fruit resembles a

26603—Continued.

flattened cone and weighs 1½ to 2 pounds, the color is green with a slight yellowish tinge, and the flesh is of good quality; the trees are good bearers most years. I do not know of any other cherimoya that excels this variety in hardiness." (*Taft.*)

(Cuttings.)

26604. AMYGDALUS DAVIDIANA (Carr.) Beiss., Sch. and Zab.

From Tientsin, China. Procured through Mr. Hamilton Butler, American vice consul general in charge. Received January 25, 1910.

See No. 22009 for previous introduction. (Seed.)

26605 and 26606. VITIS VINIFERA L. **Grape.**

From England. Presented by Rev. W. Wilks, M. A., secretary, Royal Horticultural Society, Vincent Square, Westminster, S. W., England, through Mr. David Fairchild. Received January 27, 1910.

Black Monukka. "This was sent to us from India many, many years ago. It is a very strong grower. The berries are individually small, as we do not thin them at all; they are black and seedless, one seed in perhaps 1,000 berries, and of a nice, refreshing juiciness. I like it very much, as one can strip off a handful of berries and crush them in his mouth without fear of biting on the seed, which to my mind is the greatest drawback in grapes, being of such an intensely horrible taste.

"In pruning *Black Monukka* it must not be cut quite back to last year's wood, as we do all other grapes, but must have two or possibly three eyes left on the subbranch, as it seems never to send out a spray of blossoms from the first eye as other grapes do." (*Rev. W. Wilks, letter of November 15, 1909.*)

26605. From the society's garden at Wisley.

26606. From Mr. Wilks's own garden at Shirley.

26607. LATHYRUS PARVIFOLIUS S. Watson.

From Sierra Madre Mountains, Cal. Presented by Mr. John Leenhouts, Los Angeles, Cal. Received January 17, 1910.

"I have seen these vines grow to a length of 40 feet. They seem to sprout from the roots every year and grow here plentifully over an area of, I would say, 160 acres. They seem to have originated on one of the mountain sides and to have been washed down by the rains until you find them half a mile down the foothills." (*Leenhouts.*)

Distribution.—Throughout the region west of the Rocky Mountains, from Washington to Mexico.

26612. LATHYRUS SATIVUS L.

From central Russia. Procured by Mr. Frank N. Meyer, agricultural explorer, from Mr. Engel, of the firm E. Immer & Co., Moscow. Received January 29, 1910.

"Mr. Engel claims that this plant yields 500 to 600 poods (1 pood=40 pounds) of seed per hectare, and will grow on soil where peas will not thrive. He strongly recommends making a test of it in the Middle West and says that the farmers of certain districts in central Russia consider it a favorite cattle fodder." (*Meyer.*)

26613 to 26618.

From Liesnoi Forestry Institute, near St. Petersburg, Russia. Procured by Mr. Frank N. Meyer, agricultural explorer, through the kindness of Mr. Wolff, forester in charge of the arboretum at Liesnoi. Received January 24 and 31, 1910.

26613 to 26618—Continued.

Cuttings of the following:

26613. POPULUS BALSAMIFERA SUAVEOLENS (Fisch.) Wesm. **Poplar.**

"(No. 364, December 17, 1909.) A pyramidal form of poplar of rather slow growth and of neat habits. Introduced originally from Turkestan; proves to be hardy in St. Petersburg. Recommended very much for small gardens in uncongenial climates."

26614. ×POPULUS BEROLINENSIS Koch. **Poplar.**

"(No. 365, December 17, 1909.) Variety *Rossica.* This poplar is a form of the ordinary so-called Berlin poplar, but is proving to be much hardier than the type. It is, therefore, widely planted in and around St. Petersburg as a shade tree, mostly seen stiffly clipped, but when left alone grows into a rather tall tree of open, airy habits. Recommended for cold and uncongenial climates." (*Meyer.*)

26615. SALIX VIMINALIS SPLENDENS SONGARICA Anderss. **Willow.**

"(No. 366, December 17, 1909.) A very hardy willow, of tall, bushy growth. Introduced from the Altai Mountains, central Asia. Is proving to be of much stronger and healthier growth in St. Petersburg than the European forms of *Salix viminalis.* Recommended for cold and uncongenial climates." (*Meyer.*)

26616. SALIX VIMINALIS PALLIDA (Hort.). **Willow.**

"(No. 367, December 17, 1909.) A very strong-growing willow, introduced from Siberia, proving to be very much hardier and of more healthy growth in St. Petersburg than the ordinary forms of *S. viminalis*, therefore recommended for cold and uncongenial climates." (*Meyer.*)

26617. RIBES PETRAEUM Wulf. **Currant.**

"(No. 368, December 17, 1909.) A large-fruited, very hardy species of red currant from the Altai Mountains, Turkestan, proving to be of much thriftier growth in St. Petersburg than the common red currants. May be valuable in breeding and in improving the red currant and extending its culture further northward in the United States." (*Meyer.*)

26618. ROSA GALLICA × ——?

"(No. 369, December 17, 1909.) A semidouble form, having rose-red flowers, and being extremely floriferous. Perfectly hardy in the severe climate of St. Petersburg, and proves there to be one of the most satisfactory garden roses. Recommended as an ornamental garden shrub of small dimensions in the upper Mississippi Valley States." (*Meyer.*)

26619 and 26620. HIBISCUS SABDARIFFA L. **Roselle.**

From Miami, Fla. Grown at the Subtropical Garden. Received January 29, 1910.

Seeds of the following:

26619. "The seed from which this number was grown was presented to the Department by Mr. E. N. Reasoner in 1909, he having obtained same from the West Indies.

"This variety is distinguished by its green leaves and stems, and less robust growth than the ordinary roselle. The calyxes are small and whitish in color. Mr. A. S. Archer, Antigua, British West Indies, says that in the West Indies the calyxes of this variety are not used for jelly and jam on account of the lack of color. It is, however, used in making a wine which is prepared as follows: The fruit is picked when fully ripe and the seed pods removed, after which the calyxes are washed in cold water and put into a

26619 to 26620—Continued.

stone jar—a metal jar will not do, as corrosion of the metal by the acid makes the fluid poisonous. Fill the jar with calyxes and press firmly, then pour on enough cold water to cover the calyxes and leave for 18 hours. Pour off liquid and sweeten it with best refined sugar, making it rather sweet. Pour the liquid into bottles, leaving a few inches of air space, and place in each bottle 2 or 3 bruised cloves. The corks should be well wired so that the gases generated during the fermentation can not force them out. The wine is fit to use after about three days, and has the color of champagne and is almost equal to it in taste.

"The calyxes of the red variety (S. P. I. No. 26620) may be utilized in the same way, but they make a red wine." (*Wester.*)

26620. *Victor.* "A few roselle plants were obtained from Mr. W. A. H. Hobbs, Cocoanut Grove, Fla., in 1904, and planted in the Subtropical Garden at Miami. Some of these plants bore very much larger calyxes than the rest and seed was saved from these for breeding purposes. The selection work from this stock has been carried on from year to year with the result that a strain of roselle has been obtained that has much larger calyxes than the common kind and which has been named *Victor.* In south Florida the plants of this variety are more dwarfed than those of the common kind, seldom exceeding 5 feet in height. On the richer soil in the Gulf States farther north it is of exceedingly robust growth, frequently attaining a height of more than 8 feet.

"The measurements of the calyxes are 49 mm. in length and 28 mm. in diameter. They are strongly ribbed longitudinally and frequently inclined to be convolute at the apex.

"The seed may be planted where the plants are to grow, a few to each hill, 4 to 8 feet apart, in rows 6 to 10 feet apart, according to the fertility of the land and the moisture supply, or the seed may be sown in a seed bed and the plants transplanted to the field when they are 3 to 4 inches high. They do not succeed on poorly drained land. The roselle plant is peculiar in that no matter what time seed is planted it does not bloom until the latter part of October, the first calyxes being ready for picking 15 to 18 days from the time of blooming, consequently, the plant can be grown for its fruit only in the extreme south. A fruit sirup may be made from the leaves and tender stems of the plant, and jelly has also been obtained, but it lacks the brilliant color and also the firmness of the jelly made from the calyxes." (*Wester.*)

26621 to 26642. MEDICAGO SATIVA L. **Alfalfa.**

From Stockton, Kans. Grown under the supervision of Mr. Charles J. Brand, on the farm of Mr. E. Bartholomew, Stockton, Kans. Received January, 1909, and numbered for convenience in recording distribution, January 28, 1910.

"The following samples of seed were all produced in a comparative test of the behavior of the varieties in cultivated rows." (*Brand.*)

26621. Colorado. "Grown from S. P. I. No. 12398."

26622. Montana. "Grown from S. P. I. No. 13237."

26623. Germany. "Grown from S. P. I. No. 12748, the Eifeler lucern, a strain of alfalfa that is highly prized in the restricted area of southern Germany, including the Rhine Province and Hesse. It is grown especially in the region known as the Eifel, a range of hills reaching a maximum height of about 2,500 feet. It is not a region of great cold, the mean for the coldest month being practically identical with the mean for November at St. Paul, Minn. The Eifel has a mean annual rainfall of 25 to 36 inches." (*Brand.*)

26621 to 26642—Continued.

26624. Wyoming. "This seed was grown from P. L. H. No. 3253, which was collected from an individual plant growing without irrigation in a tough prairie sod near Cheyenne, Wyo. The parent plant was located in a pasture where it had received decidedly harsh treatment. This strain is quite uniform, and proved to be one of the most drought resistant, as well as one of the best seed producers in the experiment." (*Brand.*)

26625. Buffalo, N. Y. "Grown from S. P. I. No. 19896."

26626. *Turkestan.* "Grown from S. P. I. No. 14786."

26627. Utah. "Grown from S. P. I. No. 12409."

26628. *Turkestan.* "Grown from P. L. H. No. 3252, which was grown at the South Dakota experiment station, and originally procured from Tashkend, Turkestan."

26629. Ecuador. "Grown from S. P. I. No. 14972. This is the famous *Guaranda* alfalfa, of Ecuador, which resembles very strongly the Peruvian alfalfa described in Bulletin No. 118, of the Bureau of Plant Industry. During the winter of 1907–8 this strain killed out quite severely, the present seed being from the surviving plants. At Fallon, Nev., Mr. F. B. Headley reports that the Guaranda strain will yield four cuttings a year to three of the ordinary kind. Similar reports have been received concerning it from other sections." (*Brand.*)

26630. Kansas. "Grown from S. P. I. No. 19508."

26631. Nebraska. "Grown from P. L. H. No. 3228, which was procured from Mr. Lewis Brott, Sextorp, Nebr."

26632. New York. "Grown from S. P. I. No. 13291."

26633. Texas. "Grown from S. P. I. No. 12702."

26634. Arizona. "Grown from S. P. I. No. 13437."

26635. Kansas. "Grown from S. P. I. No. 12671."

26636. *South Dakota 167.* "This seed was grown from P. L. H. No. 3251, the so-called *Baltic* alfalfa, produced in Prof. W. A. Wheeler's experiments at Highmore, S. Dak., in 1906. In a comparative test for hardiness of 68 kinds at Dickinson, N. Dak., this variety ranked fifth." (*Brand.*)

26637. Russia. "Grown from S. P. I. No. 13857."

26638. Ecuador. "See note under No. 26629."

26639. *Turkestan.* "Grown from S. P. I. No. 9453."

26640. *Algerian.* "Grown from S. P. I. No. 9322."

26641. Tunis. "Grown from S. P. I. No. 12846, the prized *Oasis* alfalfa obtained by Mr. T. H. Kearney from the Kebilli Oasis, Tunis. This strain is not hardy north of Kansas, and is not hardy enough without selection to be of use outside of the Southwest. It produces a very fine quality of hay." (*Brand.*)

26642. France. "Grown from S. P. I. No. 12695."

26643 to 26646. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

From Mukden, Manchuria. Presented by Mr. Nelson T. Johnson, American vice consul-general in charge. Received January 21, 1910.

Seeds of each of the following; quoted notes by Mr. Johnson:

26643. Black, very similar to *Cloud*, No. 16790. "*Ho tou* or *Hei tou* (black bean) as they are known colloquially. These beans are used solely as food for cattle and horses."

26643 to 26646—Continued.

26644. Olive brown. "*Mo shih tou* or the *Mo shih* bean. This bean is mostly used for cattle feed. They also sometimes extract the oil and use it for hair tonic."

26645. Green, very similar to No. 20854. "*Ch'ing tou* or green bean. This bean is used to make bean curd, an article of food much prized by the Chinese; the sprout of this bean is also much liked."

26646. Yellow, very similar to No. 17273. "*Yüan tou* or *Huang tou* (yellow bean). This bean forms the staple crop of Manchuria, and is eaten by the natives in many ways. Oil is also extracted from them and the residuum forms the bean cake of commerce which is used so extensively in Japan for fertilizer."

26647. Canavali ensiforme (L.) DC. **Jack bean.**

From Mayaguez, Porto Rico. Presented by Mr. D. W. May, director, Agricultural Experiment Station. Received February 3, 1910.

"An upright variety grown in 1909 at Biloxi, Miss., Baton Rouge, La., and Gainesville, Fla. It makes a bushy plant 3 to 5 feet high, very different from other varieties. Seeds white." (*C. V. Piper.*)

26648 and 26649. Prunus sibirica L.

From Steglitz, near Berlin, Germany. Presented by Mr. F. Ledier, first curator, Royal Botanic Garden. Received February 3, 1910.

26648. (Cuttings.)

26649. (Seeds.)

"This has a future as a hardy ornamental shrub or small tree in our Northern States." (*F. N. Meyer.*)

26650 to 26653.

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, Government agrostologist and botanist, Transvaal Department of Agriculture. Received February 3, 1910.

Seeds of the following:

26650. Pentzia incana (Thunb.) Kuntze. **"Karroobush."**

See No. 26266 for previous introduction.

26651. Trichloris mendocina (Phil.) Kurtz.

Distribution.—Central Argentina, in the Provinces of Santa del Estero, Cordoba, and Mendoza.

26652. Elionurus argentius Nees.

Distribution.—South Africa, from German Southwest Africa, the Kalahari Desert, and Transvaal, southward to the Cape.

26653. Chaetochloa nigrirostris (Nees) Skeels. (*Panicum nigrirostre* Nees, Fl. Afr. Austr. 55. 1841. *Setaria nigrirostris* Dur. and Schinz. Fl. Afr. 5: 771. 1895.)

The name *Setaria* Beauv. Agrost. 51. pl. 13. f. 3. 1812, is invalid as applied to a genus of grasses, since it was used earlier by Acharius, Lich. Suec. 4, 256. 1798, for a genus of lichens and in that sense replaces the genus *Alectoria* Acharius, 1810. The name *Chaetochloa* was therefore proposed by Scribner in 1897 for the genus of grasses previously known as *Setaria*.

Distribution.—South Africa from the vicinity of Klerksdorp in central Johannesburg southward through the eastern part of Orange River Colony and Natal to the Queenstown and Komgha districts in Cape Colony. Original locality,—"In altoribus ad Omsammubo, locis graminosis alt. 1,000 (Drege)."

26654 to 26656.

From Salisbury, Rhodesia, South Africa. Presented by Mr. R. McIlwaine, at the request of Mr. J. D. Riley, Box 11, Mercedes, Tex. Received February 2, 1910.

Seeds of the following. Native names as given by Mr. McIlwaine:

26654. Sclerocarya caffra Sond.

"*Marula.*" See No. 24762 for previous introduction.

26655. Flacourtia ramontchi L'Herit.

"*Mgokolo.*"

Distribution.—Common throughout India, both wild and cultivated; also in Madagascar and the East Indian islands.

26656. Sideroxylon sp.

"*Bumbulu.*"

26657. Eupatorium sp. (?)

From Paraguay. Procured by Mr. Cornelius Ferris, jr., American consul, Asuncion, Paraguay. Received February 2, 1910.

"I think this is *Caahu;* the other name is *Yoyouvetima.* It grows to a height of about 10 feet, always on the border of the woods, in wood soil. The leaves are used for dyeing wool." (*Notes taken from the packet which contained seed.*)

26658 to 26665.

From Medan, Sumatra. Presented by Dr. L. R. de Bussy. Received February 3, 1910.

Seeds of the following:

26658. Nephelium sp.

26659. Garcinia sp.

26660. Vigna unguiculata (L.) Walp. Brown seeded. **Cowpea.**

26661 and **26662.** Vigna sesquipedalis (L.) W. F. Wight.

26661. Reddish-brown seeds.

26662. Reddish-brown and white seeds.

26663 to **26665.** Stizolobium sp.

26663. Mottled black and brown seeds.

26664. Black seeded.

26665. Gray seeded.

26666 to 26688.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, February 3 and 5, 1910.

Seeds and plants as follows:

26666. Medicago sp.

From near Alupka, Crimea, Russia. "(No. 377 to 380, January 17, 1910.) Perennial alfalfas found growing in cliffs and on steep hill slopes in decomposed rock and in clayey soil. These plants will in all probability not bear heavy frosts. There are probably 2 or 3 species in this lot." (*Meyer.*)

26667. Medicago sp.

From near Kirikinesh, Crimea, Russia. "(No. 381 and 382, January 17, 1910.) Perennial alfalfas growing in earth cliffs; have very long roots and are therefore drought resistant. Probably the same as the preceding number (S. P. I. No. 26666)." (*Meyer.*)

26666 to 26688—Continued.

26668. Ononis sp.(?)

From near Kirikinesh, Crimea, Russia. "(No. 383, January 17, 1910.) An Ononis or perhaps a Lotus growing in earth cliffs together with Medicagos. Seems to be very drought resistant and may be of value as a perennial fodder plant in mild-wintered regions where dry, hot summers prevail." (*Meyer.*)

26669. Hedysarum sp.

From near Kirikinesh, Crimea, Russia. "(No. 384, January 17, 1910.) Found growing in the same localities as the preceding number (S. P. I. No. 26668), and the same remarks apply to it." (*Meyer.*)

26670. Ficus carica L. **Fig.**

From near Sebastopol, Crimea, Russia. "(No. 385, January 14, 1910.) A form of the wild fig, with very deeply lobed leaves; growing in exposed rocks; freezing back in severe winters, as was shown by the root stumps. May be experimented with in the northern limits of fig-growing sections in the United States." (*Meyer.*)

26671. Salix vitellina L.

From near Baidari, Crimea, Russia. "(No. 386, January 15, 1910.) Variety *aurea.* A handsome willow with golden-yellow twigs, growing into a tall shrub, or even a good-sized tree. Wood very brittle. Found wild in ravines and also cultivated in gardens. An ornamental garden and park tree for mild-wintered regions where dry and hot summers prevail." (*Meyer.*)

26672. Jasminum sp.

From near Baidari, Crimea, Russia. "(No. 387, January 15, 1910.) The same as No. 375 (S. P. I. No. 26766), see this number for remarks." (*Meyer.*)

26673. Medicago orbicularis (L.) All.

From near Balaklava, Crimea, Russia. "(No. 1201a, January 14, 1910.) An annual alfalfa found growing upon hill slopes and on stony, rather sterile, plains. Germinates in early winter and ripens in early summer. Much liked by sheep that graze everywhere on the hills in the Crimea; also fed in the native hay to working horses and to bulls. May be of value as a winter forage plant in the mild-wintered regions of the United States and especially in California." (*Meyer.*)

Distribution.—The countries bordering on the Mediterranean, from Spain to Mesopotamia, and from Abyssinia to the Canary Islands.

26674 to 26676. Medicago sp.

From near Balaklava, Crimea, Russia. "(No. 1202a to 1204a, January 14, 1910.) Same remarks apply to these as to the preceding (S. P. I. No. 26673)." (*Meyer.*)

26674. Medicago minima (L.) Grufb.

Distribution.—Western and southern Europe, from Sweden and Spain through middle and southern Russia to Greece, and through Asia to western India, and in northern Africa.

26675. Medicago rigidula (L.) Desr.

Distribution.—Same as No. 26673.

26676. Medicago rigidula agrestis (Ten.) Burnat.

"A rare variety." (*Meyer.*)

Distribution.—Southern France, bordering on the Mediterranean, and in Italy, Sicily, Greece, and Syria.

26666 to 26688—Continued.

26677. Medicago orbicularis microcarpa Rouy & Fouc.

From near Alupka, Crimea, Russia. "(No 1205a, January 17, 1910.) An annual alfalfa growing on hill slopes. The same remarks apply to this as to No. 1201a (S. P. I. No. 26673)." (*Meyer.*)

Distribution.—Same as No. 26673.

26678. Trigonella sp.

From near Balaklava, Crimea, Russia. "(No. 1206a, January 14, 1910.) A leguminous plant, perhaps an annual. The pods were found on some stony fields near Balaklava and also in some wild native hay that was given to horses. May be of value as a fodder plant in similar regions as mentioned for No. 1201a (S. P. I. No. 26673)." (*Meyer.*)

26679. Coronilla varia L.

From near Kirikinesh, Crimea, Russia. "(No. 1207a, January 16, 1910.) A perennial leguminous plant, making somewhat woody stems, on which the foliage persists in winter when located in sheltered nooks. Grows in dry cliffs and between bowlders and rocks. May be of value as a fodder plant in similar regions as mentioned under No. 1201a (S. P. I. No. 26673)." (*Meyer.*)

Plants of this were received under Meyer No. 404 (S. P. I. No. 26817).

26680. Pyrus salicifolia Pall.

From Balaklava, Crimea, Russia. "(No. 1208a, January 14, 1910.) The same remarks apply to this as to No. 372 (S. P. I. No. 26763)." (*Meyer.*)

Distribution.—Desert slopes of hills and mountains in the Caucasus, southern Russia and northern Persia.

26681. Malus baccata (L.) Moench. **Crab apple.**

From St. Petersburg, Russia. "(No. 1209a, December 10, 1910.) A few fruits of a form of *Malus baccata*, from Nertchinsk, Siberia, which are quite different from the ordinary form. Obtained from Prof. A. C. Doktorowitz-Grebnitzky, pomologist of the Forestry Institute at Liesnoi, near St. Petersburg, who is using this crab apple to create hardier apples by hydridizing it with *Malus prunifolia* and others." (*Meyer.*)

26682. Malus baccata × prunifolia.

From St. Petersburg, Russia. "(No. 1210a, December 10, 1910.) Obtained from the same source as the preceding number (S. P. I. No. 26681). This hybrid has better keeping qualities than the ordinary American crab apples." (*Meyer.*)

26683. Ribes petraeum Wulf.

From Liesnoi Forestry Institute, near St. Petersburg, Russia. "(No. 1211a, December 17, 1909.) Seeds from the same bushes from which cuttings were sent under No. 368 (S. P. I. No. 26617). See this number for remarks." (*Meyer.*)

Distribution.—Alpine and sub-Alpine slopes of mountains in Switzerland, northern Italy, Austria, and east to the Altai and Baikal Mountains in Siberia.

26684. Cercis siliquastrum L.

From near Kirikinesh, Crimea, Russia. "(No. 1212a, January 16, 1910.) The so-called Judas tree; a redbud of the Southern European and North African regions. Highly ornamental. Grows in sterile, stony localities, where it remains shrubby, but when planted in a good locality it grows up to be a tree 25 to 30 feet in height. Strongly recommended as an ornamental garden and park tree in mild-wintered regions where hot, dry summers prevail." (*Meyer.*)

26666 to 26688—Continued.

Distribution.—Southern Europe and western Asia, from southern France through the Tyrol and Greece to northern Persia.

26685. Jasminum sp.

From near Baidari, Crimea, Russia. "(No. 1213a, January 15, 1910.) The same remarks apply to this as to Nos. 375 and 387 (S. P. I. Nos. 26766 and 26672)." (*Meyer.*)

26686. Berberis sp.

From hills near Sebastopol, Crimea, Russia. "(No. 1214a, January 11, 1910.) A barberry growing in rocky cliffs, in gullies, and on stony mountain sides. Has very large spines, but is of ornamental habit. Suitable as an ornamental garden shrub in mild-wintered regions, where the summers are hot and dry." (*Meyer.*)

26687. Rosa gallica × ——?

From Liesnoi Forestry Institute, near St. Petersburg, Russia. "(No. 1215a, December 17, 1909.) Seeds collected from the same bushes from which cuttings were sent under No. 369 (S. P. I. No. 26618). See this number for remarks." (*Meyer.*)

26688. Juniperus excelsa Willd.

From mountains near Souchaja Retska, Crimea, Russia. "(No. 1220a, January 15, 1910.) A very beautiful juniper, with bluish-green foliage, large berries of dark violet color, and covered with a white bloom. A tall bush, but sometimes it grows into a tree 20 feet in height. Loves rocky and stony localities. A fine ornamental evergreen for mild-wintered regions, where hot and dry summers prevail. This juniper seems to occur only in the Crimea and the Caucasus." (*Meyer.*)

Distribution.—Southeastern Russia, from the Crimea through the Caucasus to the vicinity of the Caspian Sea.

26689 to 26757.

Material grown at the Subtropical Garden, Miami, Fla. Numbered for convenience in recording distribution February 7, 1910.

Plants (unless otherwise noted) of the following; descriptive notes by Mr. P. J. Wester:

26689 to 26730. Persea americana Miller. **Avocado.**

26689. *Trapp.* "Seed presented by Prof. P. H. Rolfs, Miami, Fla., January 4, 1905, from a very late fruit of this variety."

26690. "Seed presented by Mr. C. W. Butler, St. Petersburg, Fla., October, 1904. Fruited in 1909 for the first time. The fruit is of medium size, pyriform, surface smooth; greenish yellow, skin thin; quality very good; seed medium to large, filling cavity. Season, September.

26691. "Bud wood obtained from Judge White's place, Buena Vista, Fla., by Mrs. P. H. Rolfs, May 4, 1905. Fruit said to be very good, ripening late in December and early in January."

26692. "Bud wood received April 2, 1906, from Dr. F. S. Earle, Santiago de las Vegas, Cuba. Said to be a very late variety of good quality."

26689 to 26757—Continued.

26689 to 26730—Continued.

26693. "Bud wood obtained by Mr. P. J. Wester from Capt. J. A. Thompson, Cocoanut Grove, Fla., June 25, 1906. The fruit is medium to large, pyriform; color of skin dark purple; seed medium large, firm in cavity; quality very good; season, October and November."

26694. "Bud wood received July 18, 1906, from Mr. S. M. Pettit, Marco, Fla., who wrote that it was one of the best avocados in that locality. Fruited at the Subtropical Garden in 1909. Fruit large, roundish, oblong, oblique; surface smooth, green with numerous small whitish dots at apex; skin thick, separating readily from meat; color of meat yellowish, greenish next to skin, buttery and melting, but rather lacking in flavor; seed comparatively small, filling cavity. Season, September."

26695. "Bud wood received July 18, 1906, from Mr. S. M. Pettit, Marco, Fla., as being one of the best varieties growing in that vicinity. Fruited at the Subtropical Garden in 1909. Fruit medium large, pyriform, surface medium rough, pale green with numerous small whitish lenticels; skin medium thick, separating readily from meat; color of meat mainly straw yellow, greenish near skin; rich and nutty and of excellent flavor; seed medium large, filling cavity. Season, October."

26696. "Bud wood obtained by Mr. P. J. Wester from Mr. F. Harrison, Cocoanut Grove, Fla., March 27, 1907. Fruit medium large, long, pyriform; surface medium rough, color red; skin thick; quality of meat very good; seed comparatively small, filling cavity. Season, October."

26697. "Bud wood obtained from Mr. F. Harrison, Cocoanut Grove, Fla., March 27, 1907. Fruit medium to large, obliquely pyriform; color of surface reddish maroon mottled with green; meat of good quality; seed rather large, filling cavity; very prolific. Season, October."

26698. "Bud wood obtained by Mr. P. J. Wester from Mr. W. F. Powell, Fort Myers, Fla., May 22, 1907. Fruit large, pyriform; surface smooth, green; skin thin; quality very good; seed medium large, loose in cavity; prolific. Season, September. Has the reputation of being the best flavored avocado in Fort Myers."

26699. "Bud wood obtained by Mr. P. J. Wester from Mr. C. W. Butler, St. Petersburg, Fla., May 17, 1907. Fruit pyriform to round; surface smooth, yellowish; skin thin; quality good; seed loose in cavity; very prolific. Season, September to October."

26700. "Bud wood obtained by Mr. P. J. Wester from Mr. C. W. Butler, St. Petersburg, Fla., May 17, 1907. Of very good quality; prolific. Season, December."

26701. "Bud wood presented by Rev. E. V. Blackman, Miami, Fla., June 19, 1907. Fruit roundish; weight about 700 grams; surface chocolate; skin thick and leathery; seed medium large, firm, or loose in cavity; quality good. Season, September."

26702. "Bud wood obtained by Mr. P. J. Wester from Mr. E. B. Douglas, Miami, Fla., August 10, 1907. Fruit large, pyriform; surface smooth, purple; skin thin; color of meat rich yellow, flavor good; seed loose in cavity; prolific. Season, December."

26689 to 26757—Continued.

26689 to 26730—Continued.

26703. "Bud wood received from Mrs. P. H. Rolfs, Buena Vista, Fla., August 10, 1907. Fruit roundish, oblique, small to medium; color rich maroon red, very attractive; skin thick and leathery; flavor rather inferior; seed loose in cavity; matures early, which is its strongest point. It is the earliest West Indian variety that has come to my attention."

26704. "Bud wood obtained by Mr. P. J. Wester from Mrs. A. M. King, Miami, Fla., September 18, 1907. Fruit large, pyriform; surface smooth, red. Season, September."

26705. "Bud wood obtained by Mr. P. J. Wester from Mrs. A. M. King, September 18, 1907. Fruit very large, oblong, irregular; surface rough, reddish; quality good. Season, September."

26706. "Seeds received from Mr. G. B. Brackett, pomologist, United States Department of Agriculture, October 8, 1907. These were received by him from Mr. M. A. Carriker, Boruca, Costa Rica. The skin is said to be thick and woody and the flavor of the meat rich and delicate."

26707. "Bud wood received from Mr. W. H. Fulford, Fulford, Fla., October 21, 1907. Fruit pyriform, bright red, of good quality, prolific. Said to be one of the best avocados in that locality."

26708. "Bud wood received from Mr. W. H. Fulford, Fulford, Fla., October 21, 1907. Fruit very large, red, of good quality; prolific. Bud wood from one of the best trees in that locality."

26709. "Bud wood received from Mr. W. H. Fulford, Fulford, Fla. Fruit very large; surface rough, green; of very good quality; prolific. One of the best avocados in the locality."

26710. "Seeds received from Mr. William A. Taylor, United States Department of Agriculture, March 9, 1908. The fruit from which this seed was taken had been received by Mr. Taylor from Los Angeles, Cal."

26711. "Fruit sent to Mr. William A. Taylor, United States Department of Agriculture, by Mr. J. H. Walker, Hollywood, Cal. Said by Mr. Taylor to be a fruit of exceptionally fine quality and to have a hard skin; seed sent by Mr. Taylor to the Subtropical Garden, March 9, 1908."

26712. "Bud wood obtained by Mr. P. J. Wester from Capt. Thomas Hardee, Cocoanut Grove, Fla., August 11, 1908. Fruit medium to large, pyriform, purple; of exceedingly good quality; seed firm or loose in cavity; very prolific. Parent tree said to produce among the best flavored avocados in Cocoanut Grove."

26713. "Bud wood obtained by Mr. P. J. Wester from Mr. W. H. H. Hobbs, Cocoanut Grove, Fla., September 5, 1908. Weight of fruit 1,020 grams, seed 130 grams, shape round oblique; ground color green turning to red and maroon, making it very attractive; skin thick and leathery; meat greenish 3 mm. from the skin, the rest yellowish, mottled with purple streaks; quality excellent; seed loose in cavity. Matures in the early part of September."

26689 to 26757—Continued.

26689 to 26730—Continued.

26714. "Bud wood obtained by Mr. P. J. Wester from Mr. W. H. H. Hobbs, Cocoanut Grove, Fla., September 5, 1908. Fruit very similar in appearance to No. 26713, but somewhat larger; quality said to be very good and the tree a prolific bearer. Season, early part of September."

26715. "Bud wood obtained by Mr. P. J. Wester from Mr. W. H. H. Hobbs, Cocoanut Grove, Fla., September 5, 1908. Fruit medium to large, pyriform, quality good; seed loose in cavity; fairly prolific. Season, early part of September."

"The parent trees of Nos. 26713, 26714, and 26715 spring from the ground at the same point and Mr. Hobbs believes that they come from the same seed, though the fruits from the trees vary from each other to some extent."

26716. "Bud wood obtained by Mr. P. J. Wester from a tree on Judge White's homestead, Buena Vista, Fla., September 10, 1908. Fruit medium large, oblong or roundish, purple with numerous small green lenticels; skin smooth, medium thick; meat green 3 to 4 mm. next to the skin, rest yellowish mottled with purple streaks; flavor average to good; seed firm in cavity, medium large; very prolific. Ripens in early part of August and September."

26717. "Bud wood obtained by Mr. P. J. Wester from Mr. Courley, Buena Vista, Fla., September 28, 1908. Fruit reputed to be of very good quality and the tree prolific. Season, October to December."

26718. "Bud wood obtained by Mr. P. J. Wester from Prof. T. W. Mather, Miami, Fla., November 3, 1908. Fruit medium large to large, obliquely pyriform, maroon red with numerous small greenish-yellow lenticels; skin thick and leathery; meat pale yellow tinted with green and green predominating near the skin, the rest mottled with purple veins in distal end of fruit, making it rather attractive; meat rather soft; flavor good, but lacking in richness; seed firm in cavity."

26719. "Bud wood received from Mr. Walter Waldin, Miami, Fla. Fruit said to be of exceedingly good quality; medium early."

26720. "Bud wood received from Mr. Orange Pound, Cocoanut Grove, Fla., from a tree owned by Mr. Peacock, of the same place, November 28, 1908. Fruit large, pyriform, surface smooth, maroon red, greenish toward apex, skin medium thick, separating readily from meat; color of meat mainly yellowish, greenish next to skin, rich, nutty, and very delicately flavored. Seed smaller in proportion to meat than in any avocado that has come to my attention; loose in cavity. Season, November."

26721. "Bud wood obtained by Mr. P. J. Wester, through Mr. J. B. Beach, West Palm Beach, Fla., from a tree on the place of Dr. G. W. Potter, of the same place, September 1, 1909. The fruit is large, oblong or roundish, surface rather rough; green skin medium thick; meat mainly yellowish, green close to skin, of good quality; seed comparatively small, loose in cavity. Season, September."

26689 to 26757—Continued.

26689 to 26730—Continued.

26722. "Bud wood obtained by Mr. P. J. Wester from Mr. J. U. Parker, West Palm Beach, Fla., September 1, 1909. Fruit of good quality and tree a good bearer."

26723. "Bud wood obtained by Mr. P. J. Wester from Mr. D. A. Allen, West Palm Beach, Fla., September 1, 1909. Fruit round, oblique, medium large; surface medium smooth, greenish yellow splashed with light red to poppy red, with streaks of dark red toward base; skin medium thick, separating readily from meat; meat yellowish, rich, nutty, and of a very good quality; seed rather large, filling cavity; prolific. Season, October to November."

26724. "Bud wood obtained by Mr. P. J. Wester from Mr. D. A. Allen, West Palm Beach, Fla., September 1, 1909. Fruit medium, roundish, pyriform, oblique; surface smooth, green; skin thick; meat yellowish of good quality; seed rather large, firm in cavity. The parent tree is prolific. Season, August and September."

26725. "Bud wood obtained by Mr. P. J. Wester from Mr. J. B. Douglass, Miami, Fla., September 14, 1909. Fruit medium to large, pyriform, oblong; surface smooth, red; lenticels numerous, whitish; skin medium thick, separating readily from meat; meat yellowish, veined with purple, pale green close to skin, rich and nutty; quality very good; seed medium large, firm in cavity. The tree is abundantly productive. Season, September."

26726. "Bud wood obtained by Mr. P. J. Wester from Mr. J. B. Douglass, Miami, Fla., September 14, 1909. Fruit medium large, pyriform; surface maroon red, lenticels numerous, greenish brown; skin thick, separating readily from meat; meat yellowish, greenish next to skin, moderately rich and nutty; quality good; seed medium large, nearly filling cavity, a constant and prolific bearer. Season, August."

26727. "Bud wood obtained by Mr. P. J. Wester, through Dr. John Gifford, Cocoanut Grove, Fla., from a tree on the place of Mrs. Florence P. Haden, of the same place. Fruit medium large, roundish, oblate, oblique; surface medium rough, dark red to coral red, tinged with green at apex, lenticels small, mostly at apex, whitish or greenish; skin medium thick, separating readily from meat; meat yellowish, green close to skin, exceedingly rich and nutty, of very good flavor; seed medium to large, nearly filling cavity. Season, October."

26728. "Bud wood obtained by Mr. P. J. Wester, from Mr. Orange Pound, Cocoanut Grove, Fla., September 16, 1909. Fruit medium large, obliquely long, pyriform; surface rough, dark maroon, lenticels numerous, small, reddish; skin very thick, separating readily from meat; meat yellowish with purple veins, green toward skin, rather lacking in flavor, with slight acridity near apex; seed medium to small, filling cavity; very prolific. Season, September. This variety colors up the most attractively of all varieties that have come to my notice."

26729. Seeds from fruits of No. 26695.

26730. Seeds from fruits of No. 26727.

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26689 to 26757—Continued.

26731 to 26739. ANONA CHERIMOLA Miller. **Cherimoya.**

26731. "Bud wood obtained by Mr. P. J. Wester, from Mr. Wm. Freeman, Little River, Fla., August 4, 1904, and budded at the Subtropical Garden on *Anona glabra.* Fruited by means of hand pollination, 1908, and again in 1909; the first plant of this species to fruit in Florida. The fruit is small, not exceeding 385 grams in weight, and the seeds are abundant; the flavor is good. The original seed was brought by Mr. Freeman from San Jose, Costa Rica, to Little River in 1895."

26732. "Bud wood obtained by Mr. P. J. Wester, from Mr. S. K. Brown, Lemon City, Fla. According to Mr. Brown, the seed was sent to him from Callao, Peru."

26733. Seedlings grown from S. P. I. No. 26731.

26734. "Seed presented by Dr. F. Franceschi, Santa Barbara, Cal., January 12, 1909."

26735. "Bud wood presented by Mr. E. Gottfried, Miami, Fla., April 16, 1909, from a tree grown on Key Largo, Fla., from seed sent to him from Peru."

26736. "Bud wood presented by Mr. E. Gottfried, Miami, Fla., April 16, 1909, from a tree grown on Key Largo, Fla., from seed sent to him from Peru."

26737. "Bud wood received from Dr. F. Franceschi, Santa Barbara, Cal., December 8, 1908. This variety has been introduced and grown under the name of *macrocarpa* in California, but it has no botanical standing as a separate species. It is evidently a very robust form of the *cherimola.*"

26738. "Bud wood received from Dr. F. Franceschi, Santa Barbara, Cal., December 8, 1909. This variety was introduced and is grown in California under the name of *Anona suavissima.*"

26739. "Bud wood received from Dr. F. Franceschi, Santa Barbara, Cal., December 8, 1908. This variety has been introduced and grown in California under the name of *Anona reniformis.*"

26740 to 26746. ANONA SQUAMOSA L. **Sugar-apple.**

26740. "Bud wood obtained by Mr. P. J. Wester, on Upper Metacumbie Key, Fla. From the earliest fruiting tree that has come to my attention."

26741. "Bud wood obtained by Mr. P. J. Wester, from Mr. J. B. Douglass, Miami, Fla. The fruit is of good quality and the tree a prolific bearer. Said to bear fruit very late."

26742. "Bud wood obtained by Mr. P. J. Wester, from Prof. P. H. Rolfs, Buena Vista, Fla. Fruit large, skin pinkish in color, quality very good, rather a shy bearer."

26743. "Bud wood obtained by Mr. P. J. Wester, from Prof. P. H. Rolfs, Buena Vista, Fla., September 10, 1908. Fruit medium large; skin pinkish, quality very good."

26744. "Bud wood obtained by Mr. P. J. Wester, from Prof. P. H. Rolfs, Buena Vista, Fla., September 19, 1908. Fruit small, of good quality, exceedingly prolific, a little later in season than the main crop."

26689 to 26757—Continued.

26740 to 26746—Continued.

26745. "Bud wood obtained by Mr. P. J. Wester, from the Rev. L. S. Rader, Miami, Fla., September 18, 1908. The fruit from this tree is the largest of this species that has come to my attention; of good quality."

26746. "Seed received at the Subtropical Garden, Miami, Fla., September 22, 1908, from Mr. Henry F. Schultz, Ancon, Canal Zone, Panama.

26747 and 26748. Anona reticulata L. **Custard-apple.**

26747. "Bud wood obtained by Mr. P. J. Wester from Mr. Cephas Pinder, Upper Metacumbie Key, Fla., April, 1906."

26748. "Bud wood obtained by Mr. P. J. Wester from Mr. Cephas Pinder, Upper Metacumbie Key, Fla., April, 1906. The bud wood of this and the preceding number was taken from what Mr. Pinder considered his best custard-apple tree."

26749. Anona senegalensis Pers.

"Seed received from Reasoner Bros., Oneco, Fla., September 18, 1908."

26750. Anona sp. (?)

"Bud wood received from Mr. E. N. Reasoner, Oneco, Fla., April, 1908."

26751. Anona sp. (?)

"Bud wood received from Mr. E. N. Reasoner, Oneco, Fla., April, 1908. The seed from which Mr. Reasoner's trees grew was sent to him many years ago by Mr. C. J. Harvey, Sanborn, Mexico, who wrote Mr. Reasoner that the fruit was very delicious."

26752. Anona sp.

"Three plants received from Mr. O. F. Cook, February 12, 1909, who obtained the seed in Mexico."

26753. Anona sp.

"*Soucoya.* Seed received from Dr. F. Franceschi, Santa Barbara, Cal., March 17, 1909."

26754. Anona squamosa L.

"A tree that is very prolific, fruit of good quality."

26755. Psidium guajava L. **Guava.**

Seed received from Dr. H. J. Webber, December 12, 1906. A few of the plants raised from this seed have fruited and proved to be very superior to the common sorts."

26756. Psidium friedrichsthalianum (Berg) Niedenzu.

Plants received from Mr. E. N. Reasoner, Oneco, Fla., December 4, 1908.

"From Costa Rica. Extremely acid fruit, similar to *P. araça;* of value in cookery." (*Reasoner.*)

Distribution.—Reported only from Guatemala, South America.

26757. Psidium araça Raddi.

Plants received from Mr. E. N. Reasoner, Oneco, Fla., December 4, 1908.

"Native of Brazil. Fruit extremely acid, of medium size, not very seedy." (*Reasoner.*)

Distribution.—Spontaneous and cultivated in the Caribbean islands and the northern part of South America, occurring in Guatemala, Peru, English and Dutch Guiana, and in the provinces of Solimoes, Ciara, Bahia, Minas Geraes, and Rio de Janeiro, Brazil.

26758 and 26759. MEDICAGO SATIVA L. Alfalfa.

From Mitchell, S. Dak. Presented by Prof. W. A. Wheeler, through Mr. Charles J. Brand. Received February 10, 1910.

Seeds of the following:

26758. "(*S. D. No. 240;* acclimatized *Turkestan* alfalfa.) This seed is the 1909 progeny of S. P. I. No. 991, and was grown at Mitchell, S. Dak. It is one of the hardiest of all the alfalfas that have been tested by the department, ranking second only to the *Grimm* alfalfa of Minnesota. In an experiment at Dickinson, N. Dak., including 68 kinds, it was exceeded in hardiness only by Minnesota and North Dakota *Grimm.*" (*Brand.*)

26759. "(*S. D. No. 167;* so-called *Baltic* alfalfa.) This is one of the very promising alfalfas for cold climates, and at Dickinson, N. Dak., ranked fifth in winter hardiness of 68 kinds. For detailed information as to its origin, see S. P. I. No. 25806." (*Brand.*)

26760. ZIZANIA LATIFOLIA (Griseb.) Stapf.

From Tamsui, Formosa. Presented by Mr. Samuel C. Reat, American consul. Received February 5, 1910.

"This plant, which is closely related botanically to American wild rice, is, however, a perennial, which perpetuates itself by underground rootstocks. It grows wild and is also cultivated in various parts of China, Japan, and Formosa, and is the source of three separate food products, which are: The seeds, a fungus growth produced in the inflorescence, and the succulent vegetative shoots, which are produced from the rootstocks. The plant has a number of Chinese names, the most common of which is '*Ku.*' It is also known in the vicinity of Canton as '*Chiao sun,*' at Shanghai as '*Chiao pai,*' and at Peking as '*Chiao kwa.*' According to Bretschneider, the fungus growth in the inflorescence (*Ustilago esculenta* P. Henn) is known as '*Ku shou.*' This fungus, which is said to be edible when young, is probably not unlike the smut occurring in the inflorescence of Indian corn, which latter is sometimes eaten by the Mexican Indians. The seed of this plant is apparently not generally used for food in China, as are the other parts, though mention of their use as human food is made in very early Chinese literature. The plant is said to be cultivated extensively in the vicinity of Canton, China." (*C. S. Scofield.*)

26761 to 26767.

From Sebastopol, Crimea, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, February 9, 1910.

Cuttings of the following:

26761. MORUS ALBA L. **White mulberry.**

From estate of Maximoff, near Sebastopol, Crimea, Russia. "(No. 360, January 11, 1910.) Variety *fastigiata.* A handsome fastigiate form of the Russian mulberry, resistant to drought and heat. Suitable as an ornamental garden and park tree, especially in the semiarid, hot-summered regions of the United States." (*Meyer.*)

26762. SALIX BABYLONICA L. **Willow.**

From estate of Maximoff, near Sebastopol, Crimea, Russia. "(No. 371, January 11, 1910.) Variety *aurea.* A willow with golden-yellow branches, which are very pliable. It is apparently drought and heat resistant, and can be grown, as a producer of tying material, in the semiarid, hot-summered regions of the United States." (*Meyer.*)

26761 to 26767—Continued.

26763. Pyrus salicifolia Pall. (?)

From hills near Sebastopol, Crimea, Russia. "(No. 372, January 11, 1910.) A wild pear growing on exposed, stony mountain sides and in cliffs and gullies. It grows up to 20 feet high, but is more generally seen as a tall bush, very variable as to shape and outlines; young branches and foliage very downy. Apparently very drought resistant. Will probably be of value as a stock for pears in the semiarid, hot-summered regions of the United States and especially for the Southwest." (*Meyer.*)

26764. Pyrus salicifolia Pall. (?)

From hills near Sebastopol, Crimea, Russia. "(No. 373, January 11, 1910.) A very compact-growing, round-headed variety of the preceding number (S. P. I. No. 26763). Of use as an ornamental garden tree of small dimensions in the semiarid, hot-summered regions of the United States." (*Meyer.*)

26765. Crataegus orientalis Pall. (?)

From hills near Sebastopol, Crimea, Russia. "(No. 374, January 11, 1910.) A hawthorn growing on dry and stony places. Mostly seen as a shrub, but also growing into a small tree. Able to stand considerable drought, heat, and neglect. Of value as an ornamental garden tree and as a stock for pears in the semiarid, hot-summered regions of the United States." (*Meyer.*)

Distribution.—A tree or shrub, growing in the edges of the forests on the mountain slopes of Greece and Asia Minor.

26766. Jasminum sp.

From hills near Sebastopol, Crimea, Russia. "(No. 375, January 11, 1910.) A jasmine, apparently closely allied to *J. nudiflorum;* has bright-green branches in winter, is of bushy growth, reaching a height of only a couple of feet. Found on stony mountain sides in somewhat shady places. May prove of value as a small ornamental garden shrub in the mild-wintered semiarid regions of the United States." (*Meyer.*)

26767. Ligustrum sp.

From hills near Sebastopol, Crimea, Russia. "(No. 376, January 11, 1910.) A low, bushy, semi-evergreen privet, perhaps a variety of *L. vulgare;* grows on dry, rocky, mountain sides in somewhat shady places. Of use as a garden shrub in the semiarid regions of the United States." (*Meyer.*)

26768. Lucuma multiflora DC. **"Jacana."**

From Mayaguez, Porto Rico. Presented by Mr. W. E. Hess, Agricultural Experiment Station. Received February 9, 1910.

"Fruit 1½ to 2 inches long and wide. Some are pointed, others almost round; seeds one-third inclosed in a sweet, mealy pulp. The pulp is edible, texture and color strongly suggesting the yolk of a hard-boiled egg.

"On account of its large, lustrous foliage and symmetrical growth this tree should be valuable as an ornamental avenue tree for south Florida and California. It might also prove a vigorous stock for the egg fruit (*Lucuma nervosa* DC.); the fruit of this species is delicious, but it seems to be a very slow grower.

"I found Lucuma seed very slow in germinating. The fresh seeds require 3 to 5 months for germination, but after germinating they grow very rapidly." (*Hess.*)

Distribution. Porto Rico and other West Indian islands; cultivated in southern Florida and California.

26769. Hibiscus sp.

From Tientsin, China. Presented by Mr. F. Bade, through Mr. Hamilton Butler, American vice consul-general in charge. Received January 25, 1910.

"Probably a Japanese single variety." (*Bade.*)

26771 to 26782. DIOSPYROS KAKI L. f. **Persimmon.**

From Yokohama, Japan. Purchased from the Yokohama Nursery Co. Received February 10, 1910.

Cuttings of the following:

26771. *Daidaimaru.*
26772. *Emon.*
26773. *Fuyugaki.*
26774. *Gosho-gaki.*
26775. *Hachiya.*
26776. *Hiayakume.*
26777. *Kurokuma.*
26778. *Minozuru.*
26779. *O-gosho.*
26780. *Tanenashi* (seedless).
26781. *Tauba-gaki.*
26782. *Tsuru-no-ko.*

26783. BRASSICA PEKINENSIS (Lour.) Skeels. **Pe tsai cabbage.**

Presented by Mr. Maurice de Vilmorin, Paris, France, through Mr. Walter T. Swingle. Received January 25, 1910.

"Seeds of Chinese Pe tsai which I got from Abbé Martin, Gan pin Koëy, who says: 'I tried your improved Pe tsai but prefer the strain of this Province. Instead of extending many leaves this one makes a very white and tender head. It may be sown at the same time, but plant it much closer, as they do for salads. It is peculiarly good after the first hoarfrost.' " (*Vilmorin.*)

26784. CHLOROPHORA TINCTORIA (L.) Gaud.

From Paraguay. Procured by Mr. Cornelius Ferris, jr., American consul, Asuncion, Paraguay, from Mr. Conrado Kraus, horticulturist. Received February 17, 1910.

Tata-yuba. A tree with gray bark, and sometimes armed with thorns. The wood is yellow and furnishes a dye.

Distribution.—From the State of Vera Cruz, in southern Mexico, south through Central and South America to Paraguay; also in the West Indies.

26785. RHUS CORIARIA L. **Sicilian sumac.**

From Portici, Italy. Presented by Prof. L. Savastano, R. Scuola di Agricoltura. Received February 11, 1910.

"Seed of the well-known Sicilian sumac, a native of central Europe, occurring in Sicily, Spain, Portugal, Greece, and Cyprus. It has also been introduced into Algeria and some parts of Australia. The cultivation of this shrub and the marketing of the dried leaves, which are used for mordanting fabrics and tanning certain types of leather, forms an important industry in Sicily and Tuscany. In its native habitat this species succeeds well on dry and rather barren soil. It may be propagated either from seeds or cuttings, and its cultivation presents no special difficulties. Introduced for testing its possibilities as a cultivated crop." (*W. W. Stockberger.*)

26786. ALYSICARPUS VAGINALIS (L.) DC.

From the Island of Guam. Presented by Mr. J. B. Thompson, special agent in charge, Agricultural Experiment Station. Received February 8, 1910.

"This is an annual, upright legume, isolated plants growing to a height of 6 feet; when growing thickly, however, it attains a height of only 3 or 4 feet. Its economic possibilities were first recognized by Mr. J. B. Thompson, who found it growing extensively in certain parts of the Philippines. The plant is an annual, but under favorable circumstances grows again from the base, so that two or even three cuttings can be made. It should be extensively experimented with, especially in the Southern States where alfalfa can not be grown." (*C. V. Piper.*)

Distribution. Throughout the tropics of the Old World, and naturalized in Jamaica, Antigua, and Trinidad.

26787. STIZOLOBIUM sp.

From Medan, Sumatra. Presented by Dr. L. R. de Bussy. Received February 3, 1910.

Seed gray mottled with brown.

NOTE.—This seed was picked out of the lot to which S. P. I. No. 26665 was assigned, by Prof. Piper.

26788 and 26789. CICER ARIETINUM L. **Chick-pea.**

From New York, N. Y. Purchased from Mr. J. Schindel. Received February 8, 1910.

Seeds of the following:

26788. *Spanish.*
26789. *California.*

26790. BRASSICA CAMPESTRIS L. **Swedish turnip.**

From New York, N. Y. Purchased from Messrs. J. M. Thorburn & Co. Received February 11, 1910.

Yellow Finland. To be grown at the Agricultural Experiment Station, Sitka, Alaska, in a comparative test with the *Petrowski* turnip, S. P. I. No. 19554, which has proved so well adapted to conditions there.

26791 and 26792. ROSA LAEVIGATA Michx.

From Redlands, Cal. Presented by Mr. Sydney Hockridge. Received at the Plant Introduction Garden, Chico, Cal., January, 1910.

Plants of the following:

26791. *Cherokee.*

26792. Variety *anemone.* The European pink hybrid, a rare and beautiful variety.

26793. PRUNUS PSEUDO-CERASUS Lindl.

From Yokohama, Japan. Purchased from the Yokohama Nursery Company. Received February 11, 1910.

See No. 25087 for description.

26794 to 26797. PUNICA GRANATUM L. **Pomegranate.**

From Hwai Yuan, China. Presented by Dr. Samuel Cochran, American Presbyterian Mission. Received February 9, 1910.

Cuttings of the following; notes by Dr. Samuel Cochran:

26794. "*Manao shihliu,* Carnelian pomegranate. The fruit is long instead of round, and the end attached to the twig is pointed. Kernels are large and the flavor good."

26795. "*Yushih tzu-tzu shihliu,* Jade seed pomegranate. White kernels, 'like rock candy,' my friend says. The flavor is good and does not cloy. The most valued variety we have."

26796. "*Peh-hwa shihliu,* white-flowered pomegranate. So called from the color of the blossom. The leaves are not red when first opened as are other varieties; the fruit is not ruddy like others and the kernels are white; the fruit is large, but rots easily and drops from the tree, so the yield is small. It is of good flavor."

26794 to 26797—Continued.

26797. "Cuttings from different trees of good unnamed sorts. I do not know if they really would constitute separate varieties. My friend, Mr. Sung Shao Ru, says they are good kinds he selected carefully."

"It is said that the Hwai Yuan pomegranates are the best in China, and I think it is very likely true. I believe they are sent from here for the Emperor's use. These cuttings were gathered for me by a friend who is a great tree lover and skilled in arboriculture so far as it is known in this part of the world. I have not seen the trees nor eaten the fruit of the particular ones from which these cuttings were taken, but I rely on what he says." (*Cochran.*)

26798. CYTISUS BIFLORUS L'Herit.

From Sarepta, Russia. Collected by Mr. K. B. Christies, presented by Mr. W. von Arapow, agronomist of Samara, Russia, through Mr. C. S. Scofield. Received January 26, 1910.

"This plant has a prostrate woody stem 1 to 3 decimeters long, with slightly oval leaves less than an inch long. It has been used somewhat in Europe as an ornamental, but from its description it does not appear to be promising as a forage plant." (*P. L. Ricker.*)

Distribution.—Southern Russia, and in Siberia, especially on the slopes of the Ural and Altai Mountains.

26799. ALEURITES FORDII Hemsl. **China wood-oil tree.**

From Audubon Park, New Orleans, La. Procured by Mr. Peter Bisset. Received February 14, 1910.

Grown from S. P. I. No. 13104. See S. P. I. No. 25081 for description.

26800. ROBINIA PSEUD-ACACIA L.

From Kew, England. Presented by the Royal Botanic Garden. Received February 17, 1910.

Variety *fastigiata*. "This curious tree, now seldom seen, is represented in the collection of Leguminosæ at Kew by a specimen 50 feet or so high. In habit it is one of the most erect and columnar of this class of trees, narrower, indeed, in proportion to its height than the Lombardy Poplar." (*W. J. Bean, Gardeners' Chronicle, March 9, 1907.*)

NOTE.—Linnæus in the Species Plantarum, 1753, vol. 2, p. 722, published the above specific name as two words, "*Robinia Pseudo Acacia.*" In the second edition of the Species Plantarum, 1763, vol. 2, p. 1043, the name was changed to "*Robinia Pseud-Acacia,*" and the latter is here accepted as the correct form.

26801 to 26817.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, February 12, 1910.

Cuttings of the following:

26801. OLEA EUROPAEA L. **Olive.**

From Nikita, Crimea, Russia. "(No. 388, January 22, 1910.) Cuttings from a very large olive tree, several centuries old, growing in the Imperial Botanical Garden at Nikita, and bearing large fruits. This and following numbers (S. P. I. Nos. 26802 to 26811) are cuttings of olive trees that have withstood temperatures of about −2° F. unhurt when other olives were frozen to the

26801 to 26817—Continued.

ground. They can therefore be recommended for southern Texas and for the interior valleys of California, where heavy frosts are occasionally experienced." (*Meyer.*)

26802 to 26811. Olea europaea L. **Olive.**

From Nikita, Crimea, Russia. "(Nos. 389 to 398, January 22, 1910.) These cuttings have been cut from trees between 60 and 70 years of age, otherwise the same remarks apply to them as to No. 388 (S. P. I. No. 26801). Each of these numbers is a different variety, but as yet they have not been named by the Russians." (*Meyer.*)

26812. Populus sp. **Poplar.**

From Orianda, Crimea, Russia. "(No. 399, January 25, 1910.) A variety of poplar with whitish trunk, growing remarkably pyramidal and tall. The young trees seem to shoot up until they are about 80 feet tall, and then when getting older they branch out somewhat and lose their spire-like shape. To be recommended for regions where hot and dry summers prevail, followed by fairly mild winters." (*Meyer.*)

26813 and 26814. Medicago spp. **Alfalfa.**

From near Yalta, Crimea, Russia. "(Nos. 400 and 401, January 24, 1910.) An alfalfa growing in dry earth cliffs, having very long and strong roots. Perhaps a variety of the ordinary *M. sativa*. See also Nos. 377 to 382 (S. P. I. Nos. 26666 and 26667) for further remarks." (*Meyer.*)

26815. Medicago sp.

From near Nikita, Crimea, Russia. "(No. 402, January 24, 1910.) Apparently like the preceding numbers (S. P. I. Nos. 26813 and 26814), but found in a different locality." (*Meyer.*)

26816. Melilotus taurica (Bieb.) Ser.

From near Nikita, Crimea, Russia. "(No. 403, January 24, 1910.) A melilotus found on hill slopes in decomposed rocks. May be of value as a fodder plant in regions with dry and hot summers and mild winters." (*Meyer.*)

26817. Coronilla varia L.

From near Nikita, Crimea, Russia. "(No. 404, January 24, 1910.) Found covering a steep hill slope of decomposed rock. Seeds sent under No. 1207a (S. P. I. No. 26679). See this number for further particulars." (*Meyer.*)

26818 to 26820.

Grown at Pullman, Wash., by Mr. M. W. Evans, season of 1909. Received fall of 1909.

Seed of the following:

26818. Onobrychis viciaefolia Scop. 1772. (*Onobrychis sativa* Lam. 1778.) **Sainfoin.**

26819. Pisum arvense L. **Pea.**

Field variety. Original seed received from Botanical Gardens, Dublany, Austria. Grown under Agrost. No. 0500.

26820. Festuca rubra L. **Red fescue.**

"A variety grown on the campus of the Agricultural College, College Park, Md., in dense shade. It would not produce seed at College Park, so was sent to Pullman, where it seeded freely." (*Evans.*)

26821 to 26835.

Grown at the Plant Introduction Garden, Chico, Cal. Numbered for convenience in recording distribution February 21, 1910.

Plants of the following varieties of fruit budded on *Amygdalus davidiana* to test it for its commercial value and congeniality as a stock for these fruits·

26821 to 26834. Budded on S. P. I. No. 22009.

26821 to 26827. AMYGDALUS PERSICA L. **Peach.**

26821. *Salway.*
26822. *Phillips Cling.*
26823. *McKevitt's Cling.*
26824. *Tuscan.*
26825. *Levey's.*
26826. *Alexander.*
26827. *Heath Cling.*

26828 to 26831. PRUNUS DOMESTICA L. **Prune.**

26828. *Fellenberg.*
26829. *French.*
26830. *Sugar.*
26831. *Pond Seedling.*

26832. PRUNUS ARMENIACA L. **Apricot.**

Moorpark.

26833. PRUNUS TRIFLORA (× ———). **Plum.**

Wickson.

26834 and 26835. AMYGDALUS COMMUNIS L. **Almond.**

26834. *I. X. L.*

26835. Budded on S. P. I. No. 21227.

Nonpareil.

26839 and 26840. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

From Kalgarh, Midnapur, India. Presented by Mr. A. L. Keenan. Received February 17, 1910.

Seeds of the following:

26839. Large black seeded.
26840. Small black seeded.

26841 and 26842.

From Hangchow, China. Presented by Mr. John L. Stuart, Southern Presbyterian Mission. Received February 11 and 12, 1910.

Seeds of the following:

26841. CANNABIS SATIVA L. **Hemp.**

26842. BOEHMERIA NIVEA (L.) Gaud. **Ramie.**

"The women use the bark of this for thread and strings and also make a coarse cloth from it." (*Stuart.*) Chinese name *Ch'u ma*, or *Tchou ma.*

26844. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From Vinemont, Ala. Purchased from Mr. E. C. Townsend. Received February 19, 1910.

Townsend. "A smooth white-seeded pea with a medium brown eye. This pea bunches like the speckled or Whippoorwill pea and is good for the table or stock." (*Townsend.*)

26850. PHOENIX DACTYLIFERA × CANARIENSIS. (?)

From Audubon Park, New Orleans, La. Procured by Mr. Peter Bisset. Received February 12, 1910.

For the introduction of a cross similar to this see S. P. I. No. 3120.

26851. CHLORIS GAYANA Kunth. **Rhodes-grass.**

From Sydney, New South Wales, Australia. Purchased from Messrs. Anderson & Son. Received February 19, 1910.

Distribution.—Africa, from Abyssinia south to the Transvaal region.

26853 and 26854. GARCINIA spp.

From Buitenzorg, Java. Presented by Mr. H. Wigman, jr., Department of Agriculture. Received February 18, 1910

Seeds of the following:

26853. GARCINIA COWA Roxb.

For distribution of this species see No. 24769.

26854. GARCINIA DIOICA Blume.

Distribution.—Mountain slopes in the Provinces of Buitenzorg, Tjanjor, and Bantam, on the island of Java.

26855 and 26856.

From Mayaguez, Porto Rico. Presented by Mr. W. E. Hess, Agricultural Experiment Station, through Mr. P. J. Wester. Received February 23, 1910.

26855. ANONA PALUSTRIS L.

"A small tree indigenous to tropical America, 24 to 30 feet high, the trunk reaching 10 or 12 inches in diameter, inhabiting swampy and marshy localities. The fruit is said to be inedible." (*Wester.*) (Plants.)

Distribution.—Native and cultivated from the State of Vera Cruz in southern Mexico southward to Brazil, in the West Indies, and in the Senegambia region of Upper Guinea, Africa.

26856. RHODOMYRTUS TOMENTOSA (Ait.) Wight.

See No. 25891 for description.

26857 and 26858.

From Shanghai, China. Presented by Rev. J. M. W. Farnham. Received January 31, 1910.

Seeds of the following:

26857. CHAETOCHLOA ITALICA (L.) Scribn. **Siberian millet.**

26858. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

Yellow.

26862 to 26865.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, February 24, 1910.

Plants of the following:

26862. FAGUS sp.

From near Gagri, Caucasus, Russia. "(No. 406, February 2, 1910.) A tall tree in the forest, having a whitish trunk, like the native American beech. Seems to like somewhat shady, cool places. Of value as a shade and timber tree in the moist, mild-wintered sections of the United States." (*Meyer.*)

26863 and 26864. VIOLA sp. **Violet.**

From near Gagri, Caucasus, Russia. "(Nos. 411 and 412, February 1, 1910.) A violet, found growing on semishady, rather dry places a few hundred feet above sea level. Bears small blue flowers which are quite fragrant. Is apparently more drought and heat resistant than the ordinary violets, some specimens even possessing more or less of a taproot. This may be of value in breeding a more drought and heat resistant strain of this favorite flower." (*Meyer.*)

26862 to 26865—Continued.

26865. MEDICAGO sp.

From Novorossysk, Caucasus, Russia. "(No. 415, January 29, 1910.) Alfalfas growing on stony and clayey hillsides near Novorossysk. The summer is very hot and dry in this region, but the winter is mild and generally very wet." (*Meyer.*)

26866 to 26884.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, February 5, 1910.

Seeds of the following:

26866. ROSA sp.

From near Sebastopol, Crimea, Russia. "(No, 1216a, January 11, 1910.) A wild rose found in gullies and at the bases of rocky hills. A very strong grower. May serve as a stock for fine varieties of roses in mild-wintered regions, where the summers are hot and dry." (*Meyer.*)

26867. ROSA sp.

From near Sebastopol, Crimea, Russia. "(No. 1217a, January 11, 1910.) A wild rose of medium strong growth, found on similar places as the preceding number (S. P. I. No. 26866) and perhaps of value as a stock." (*Meyer.*)

26868. ROSA sp.

From near Baidari, Crimea, Russia. "(No. 1218a, January 15, 1910.) A wild rose growing in abundance in thickets and semishady places, has few spines. May be of use in hybridizing work and as a stock like the preceding numbers (S. P. I. Nos. 26866 and 26867)." (*Meyer.*)

26869. ROSA sp.

From Balaklava, Crimea, Russia. "(No. 1219a, January 14, 1910.) A wild rose of very bushy habit, occurring on rather sterile and stony fields. May be of value as an ornamental shrub in regions where the winters are fairly mild and the summers hot and dry." (*Meyer.*)

26870. SORBUS sp. **Mountain ash.**

From near Baidari, Crimea, Russia. "(No. 1221a, January 15, 1910.) Found on dry and exposed places, remaining rather shrubby. Apparently able to withstand more heat and drought than the ordinary mountain ashes, and therefore recommended for regions with mild winters and hot and dry summers." (*Meyer.*)

26871. CRATAEGUS sp.

From near Sebastopol, Crimea, Russia. "(No. 1222a, January 11, 1910.) A tall shrub, growing sometimes into a tree. Found on rather stony and sterile places. Of value as an ornamental plant and as a stock for pears in mild-wintered regions, where hot and dry summers prevail." (*Meyer.*)

26872. CRATAEGUS sp.

From Balaklava, Crimea, Russia. "(No. 1223a, January 16, 1910.) A shrubby hawthorn bearing a few black, juicy berries. Found growing in a thicket. Of value as an ornamental shrub in regions like the preceding (S. P. I. No. 26871)." (*Meyer.*)

26873. CRATAEGUS sp.

From near Kirikinesh, Crimea, Siberia. "(No. 1224a, January 16, 1910.) A tall, shrubby hawthorn, found growing in fields. Of value like the preceding number (S. P. I. No. 26872)." (*Meyer.*)

26866 to 26884—Continued.

26874. Cotoneaster pyracantha (L.) Spach.

From near Baidari, Crimea, Russia. "(No. 1225a, January 15, 1910.) This very ornamental evergreen hawthorn grows in its native habitat in rather sterile and exposed places, and where it is browsed upon by sheep and goats assumes very low, rounded shapes. Can probably be employed as a low evergreen for hedges and borders in fairly mild-wintered regions, with hot and dry summers." (*Meyer.*)

Distribution.—Southern Europe and western Asia, extending from Spain to Macedonia and eastward through Asia Minor to Syria. Naturalized in the United States from Pennsylvania to Tennessee and south to Alabama.

26875. Crataegus sp.

From near Sebastopol, Crimea, Russia. "(No. 1226a, January 11, 1910.) A small tree, found at the foot of an embankment. Apparently quite rare. Of value as an ornamental, tall shrub or small tree in regions with dry and hot summers and fairly mild winters." (*Meyer.*)

26876. Crataegus sp.

From near Baidari, Crimea, Russia. "(No 1227a, January 14, 1910.) A low shrub, found growing in dry and stony places. Of value like the preceding number (S. P. I. No. 26875)." (*Meyer.*)

26877. Ligustrum vulgare L. **Privet.**

From near Baidari, Crimea, Russia. "(No. 1228a, January 15, 1910.) Collected from some shrubs, found growing on very dry and exposed places. This privet seems to be able to stand more drought and heat than is generally supposed. Of value as an ornamental shrub in regions with dry and hot summers and fairly mild winters." (*Meyer.*)

Distribution.—Europe, western Asia, and northern Africa; cultivated in the United States as a hedge plant, and naturalized locally from Maine to Ontario and south to North Carolina.

26878. Carpinus betulus L. **European hornbeam.**

From near Sebastopol, Crimea, Russia. "(No. 1229a, January 11, 1910.) This well-known shrub, growing into a medium-sized tree, occasionally, is found in abundance on the hills and mountains of the Crimea, where it withstands heat and drought on even very sterile mountain sides remarkably well. Of value as an ornamental and as a hedge plant in similar regions as the preceding number (S. P. I. No. 26877)." (*Meyer.*)

Distribution.—Europe and western Asia; from southern England and Sweden to the Mediterranean, and east through southern Russia to Persia.

26879. Paliurus spina-christi Mill. **Christ's-thorn.**

From near Sebastopol, Crimea, Russia. "(No. 1230a, January 9, 1910.) A Zizyphus-like shrub, with many hooked spines, growing in abundance here and there on dry stony places. A bad weed apparently. Of value as a botanical specimen in arboreta and botanical gardens." (*Meyer.*)

Distribution.—Southern Europe and Asia; from Switzerland through Hungary and Greece to Persia; also reported from the province of Shensi, northern China.

26880. Viburnum lantana L. **Wayfaring tree.**

From Baidari, Crimea, Russia. "(No. 1231a, January 15, 1910.) An ornamental Viburnum found in a thicket; this was the only specimen. Of value as an ornamental shrub in regions with hot and dry summers and fairly mild winters. (*Meyer.*)

26866 to 26884—Continued.

Distribution.—Southern Europe, western Asia, and northern Africa; cultivated in the United States as an ornamental shrub, and occasionally escaped along roadsides.

26881. HERACLEUM sp.

From near Kirikinesh, Crimea, Russia. "(No. 1232a, January 16, 1910.) A Heracleum with very large umbels. Found on a stony mountain side. Of value as an ornamental plant in parks and large gardens in mild-wintered regions where hot and dry summers prevail." (*Meyer.*)

26882. RUSCUS ACULEATUS L. **Butcher's-broom.**

From near Kirikinesh, Crimea, Russia. "(No. 1233a, January 16, 1910.) The well-known butcher's broom, growing wild in the Crimea in open woods and in thickets on the hillsides. Used locally for brooms to clean roads and courtyards. The plant is quite ornamental, being evergreen, only a foot or so in height, and bearing large scarlet berries. Of value as a ground cover underneath trees in gardens and parks in regions with hot and dry summers and fairly mild winters." (*Meyer.*)

Distribution.—From central and southern Europe east to Asia Minor, and also in northern Africa.

26883. ASPARAGUS sp.

From near Kirikinesh, Crimea, Russia. "(No. 1234a, January 16, 1910.) A climbing asparagus found once in awhile in an open thicket. Seems to be ornamental. Of value in regions like the preceding numbers." (*Meyer.*)

26884. JUNIPERUS OXYCEDRUS L. **Juniper.**

From near Sebastopol, Crimea, Russia. "(No. 1235a, January 11, 1910.) An ornamental juniper with light-green foliage, which is covered with a whitish bloom; it bears light-brown berries. Grows on very dry and sterile hill and mountain sides. Mostly seen as a spreading shrub, though occasionally reaching the size and appearance of a small tree. Of value as an ornamental evergreen in regions where hot and dry summers and fairly mild winters are experienced." (*Meyer.*)

Distribution.—Mountain slopes in the countries bordering on the Mediterranean from Spain to Persia and in northern Africa.

26885. CYCLAMEN PERSICUM Miller.

From near Gagri, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, February 24, 1910.

"(No. 419, January 31, 1910.) Tubers of the beautiful wild Cyclamen, that is flowering profusely at this time of the year, in the Caucasus. It is quite variable even in the wild state. Deserves to be naturalized in the mild-wintered regions of the United States, and will do especially well in northern and central California." (*Meyer.*)

Distribution.—In shady woods throughout Macedonia and Greece, and east to Lebanon and Palestine.

26886. PRUNUS SIMONII Carr.

From Dongsi, China. Received through Mr. Frank N. Meyer, agricultural explorer, at the Plant Introduction Garden, Chico, Cal. Numbered February 25, 1910.

"(No. 735a, June 22, 1907.) Seeds of an apricot-plum. A rare fruit that looks like an apricot, but is sour like a plum. Very fragrant, with downy, dull-yellow skin; rather small-sized. Perhaps a natural hybrid between the apricot and the plum." (*Meyer.*)

26887 to 26890. Zea mays L. Corn.

From near Tegucigalpa, Honduras. Presented by Mr. Samuel McClintock, American consul. Received February 4, 1910.

Seeds of the following; notes by Mr. McClintock:

26887. Yellow mountain corn, from the Santa Lucia region.

26888 to 26890. Corn grown on the plains, from the farm of Señor Constantino Fiallos:

26888. Bluish black.

26889. Red.

26890. Reddish yellow.

26891 to 26894.

From near Gagri, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, February 24, 1910.

Plants of the following:

26891. Ulmus sp. **Elm.**

"(No. 407, February 2, 1910.) An elm found on stony mountain sides. Of value like No. 406 (S. P. I. No. 26862)." (*Meyer.*).

26892. Tilia sp. **Linden.**

"(No. 408, February 2, 1910.) A linden growing to very large dimensions. Found in ravines in the more elevated mountain regions. Of value as an ornamental tree in the mild-wintered regions of the United States." (*Meyer.*)

26893. Fraxinus sp. **Ash.**

"(No. 409, February 2, 1910.) A very tall species of ash, found mainly on moist mountain slopes in the more elevated regions. Of value as a timber tree in the mild-wintered regions of the United States." (*Meyer.*)

26894. (Undetermined.)

"(No. 410, February 2, 1910.) A low-growing shrub, found on cliffs in shady places; perhaps of ornamental value. In appearance between a Lonicera and a Hypericum." (*Meyer.*)

26895. Vitis vinifera L. Grape.

From Aghin, fourteen hours distant from Mamuretul-Aziz (Harput), Turkey. Procured by Mr. Wm. W. Masterson, American consul, from Dr. Barnum, missionary. Received February 5 and 7, 1910.

"A kind of yellow grape of good size, which has been developed to such an extent that it is easily kept until the following May and even into June. I understand from our missionaries, who frequently visit the place, that the grapes are most excellent in flavor, and are noted throughout this country for their keeping qualities." (*Masterson.*)

26896. Bromelia sp.

From Panama. Presented by Mr. Henry F. Schultz, Ancon, Canal Zone. Received February 23, 1910.

"A small plant, which may have some value as a fiber producer. It appears to be a species of Bromelia, and in fact resembles *B. pinguin* rather closely, except that it grows tall and upright, while *B. pinguin*, as I have seen it in the jungle in different parts of the Zone and Panama, develops a trailing habit. When grown in the open, as in Chiriqui, where it is used for fencing pastures, the leaves, of course, stand up stiffly, but seldom grow higher than 3 to 4 feet, rarely 5 feet; in the woods individual

26896—Continued.

leaves frequently trail and wind through the underbrush 10 to 12 feet in length. The species sent is armed with sharp and recurved spines and the leaves stood up straight 11 to 14 feet high (measured). The mother plants grow at Mariato, Province of Veraguas, R. P., on the property of the Boston-Panama Company, on rubber land (semiwild trees)." (*Schultz.*)

26897. DIOSPYROS SENEGALENSIS Perrott.

From Hartley and Melsetter districts, Rhodesia, South Africa. Presented by Mr. H. Godfrey Mundy, agriculturist and botanist, Department of Agriculture, Salisbury, Rhodesia. Received February 24, 1910.

"Native names: *M'shuma*, *M'chenji*, *Cheehati* or *M'soko*. This tree is said to be of considerable size and the timber to be useful for building purposes. The fruit is described as resembling that of '*Mahobohobo*' (*Uapaca kirikiana* Mill.), though somewhat smaller and with a thinner skin. Three to five seeds in each fruit. Habitat, warm and sheltered river banks, and not found in dry, waterless localities." (*Mundy.*)

See No. 25634 for distribution of this species.

26898. CICER ARIETINUM L. **Chick-pea.**

From Brooklyn, N. Y. Purchased from Messrs. Labato & Lombroso. Received February 25, 1910.

Mexican.

26899. AVENA SATIVA L. **Oat.**

From Pretoria, Transvaal, South Africa. Presented by Mr. I. B. P. Evans, Transvaal Department of Agriculture. Received February 23, 1910.

Algerian. "With us, oats suffer very considerably from rust, and this variety is practically the only one that shows immunity to the pest." (*Evans.*)

To be used in breeding work for rust resistance.

26901 to 26907.

From Tientai, via Ningpo, China. Presented by Rev. A. O. Loosely, through Mr. B. Youngblood, Scientific Assistant, Farm Management Investigations, Oklahoma, Okla. Received February 28, 1910.

Seeds of the following; descriptive notes by Rev. A. O. Loosely:

26901. ERIOBOTRYA JAPONICA (Thunb.) Lindl. **Loquat.**

"*Bibo* (bee-bō). A delicious fruit growing in clusters, each fruit being smaller than a small-sized egg; it is splendid for eating raw, stewed, or made into jam or jelly. This tree produces abundantly, but the kernel is large in proportion to the size of the fruit. It may be possible to make the fruit larger by cultivation."

26902 and 26903. DIOSPYROS KAKI L. f. **Persimmon.**

26902. Seeds long and narrow.

26903. Seeds short and broad.

"I presume you have better persimmons in California, but I never saw them in the Middle West; these ought to grow in Oklahoma. The fruit of one is the size and shape of a large egg; the other is larger, round, and flat; they are a delicious fruit for eating raw or dried. They have a long season of about two months, are prolific, and a sure crop."

26901 to 26907—Continued.

26904. Actinidia sp.

"*Deng li* (deng-lee), or vine pear, so called because resembling somewhat in appearance a Chinese pear, grows among the hills. The fruit is full of small seeds and slightly resembles a fig in taste. It is good for eating raw, stewed, or made into jam."

26905. Myrica nagi Thunb.

"*Yiangme* (yiangmā), or tree strawberry. A round, bright-red, sweet, juicy fruit, growing on trees; construction similar to Osage orange or hedge apple. It is splendid for eating raw or stewed; the canned fruit must be kept in the dark, or it turns to vinegar. There is little to this fruit except juice, but it should become a favorite at once; aside from eating raw, its best use would probably be for making a drink by pressing out pulp and seeds. It will be a better shipper than the strawberry."

26906. Raphanus sativus L. **Radish.**

"Large white radish. We use these as a cooked vegetable on the table and also raw; they are best cooked with meat."

26907. Trachycarpus excelsus (Thunb.) Wendl.

"A beautiful palm, hardy even if the ground freezes slightly."

Distribution.—Cultivated, and probably indigenous, in the Provinces of Kiangsu, Chekiang, and Szechwan, of the Chinese Empire, in the Korean Archipelago, and in Japan and the island of Formosa."

26908 to 26910.

From Limon, Costa Rica. Presented by Mr. H. F. Schultz, Ancon, Canal Zone, Panama. Received February 26, 1910.

Seeds of the following:

26908. Passiflora ligularis Juss. **Granadilla.**

"One of the best flavored of all the granadillas, sometimes called *Grandita de China* in southern Mexico, and often incorrectly identified as *Passiflora quadrangularis.* It has a parchment-like shell of a yellow or orange color, sometimes speckled with minute dots of a lighter color. Its pulp has a pleasant acidulous flavor and is used in many tropical countries for making a cooling drink, and also for frozen sherbets. For this purpose it is considered superior to the 'water-lemon' (*P. laurifolia*), which may be identified by its soft, flexible skin, and the 'passion fruit,' cultivated in Australia (*P. edulis*) which is characterized by its purple-dotted surface. The flowers are ornamental, and the plant grows rapidly, soon covering trellises and arbors in warm countries." *W. E. Safford.*)

Distribution.—From the southern part of Mexico southward to Colombia and Ecuador, and in Costa Rica.

26909. Chayota edulis Jacq. **Chayote.**

26910. Anona sp.

26911. Medicago sativa L. **Alfalfa.**

From Samara Province, Russia. Received from Messrs. Vollmer & Co., Riga, Russia, through Mr. J. M. Westgate, February 28, 1910.

"This seed is of interest owing to the fact that introductions of *Medicago falcata* have been secured from this same section." (*Westgate.*)

26912. (Undetermined.)

From Macao, China. Presented by Mr. A. J. Perkins. Received February 17, 1910.

"Seeds of *San-quat*, an orange-like fruit in exterior, but having a soapy pulp and many seeds." (*Perkins.*)

26913. ZEA MAYS L. **Corn.**

From the Hacienda Maguey, situated on the Rio Santiago, a branch of the Nazas, some 70 miles northwest of the city of Durango, Mexico, at an elevation of 6,100 feet. Procured by Mr. Charles L. Freeman, American consul, Durango, Mexico, from Mr. Marion C. Dyer, manager of the Hacienda. Received March 1, 1910.

"Mr. Dyer says that this corn will mature in less time and stand the lack of moisture better than any corn he has been able to procure." (*Freeman.*)

26914 to 26916. ZEA MAYS L. **Corn.**

From Guatemala. Presented by Mr. William Owen, vice and deputy consul general, Guatemala City. Received March 1, 1910.

Seeds of the following; notes by Mr. Owen:

26914. "Mixed lowland corn. Grown near Obispo, Department of Escuintla; altitude 700 feet; matures 90 days from date of planting."

26915. "Yellow highland corn. Grown at Eureka, Department of Guatemala; altitude 4,700 feet; matures 120 days from date of planting."

26916. "White highland corn. Grown at Zarzal, Department of Amatitlan; altitude 4,200 feet; matures 120 days from date of planting."

26917. TRIFOLIUM ALEXANDRINUM L. **Berseem.**

From Tripoli, Barbary, north Africa. Procured by Mr. A. E. Saunders, American vice and deputy consul, at the request of Mr. William Coffin, American consul. Received March 1, 1910.

"*Susfa.* The native kavass here says the seed should be sown sparingly in plats about 5 or 6 feet square, with a wall of soil about a foot high around it, and the seed sown from 1 to 2 inches deep, in ruts from 3 to 4 inches wide. It must be kept well watered. The susfa should grow to a height of 4 feet or more. Cut the plant the first year for fodder only, which can be done once a month, or oftener, taking care not to disturb the roots. For seed the second year's growth is better. As fodder it is very good for cows and horses, goats, etc., and need not be mixed with other food." (*Saunders.*)

Distribution.—The countries along the eastern part of the Mediterranean from Greece to Syria and Palestine, and in Egypt and Tripoli.

26918. CITRUS sp. **Sour orange.**

From Zimapan, Hidalgo, Mexico. Presented by Mr. Jorge J. White. Received March 2, 1910.

"Cuttings of what appears to me to be a very hardy and prolific orange. It has been under my observation for over a year and I have kept track of it for 1 year exactly. It is growing under adverse conditions, having only 2 feet of very poor soil, and receiving only the moisture from rains, which are scant here; under the soil is straight limestone, somewhat decomposed, for 2 or 3 feet, when it changes to the usual blue lime of this country. The tree is rather dwarf, being about 10 feet high; the head is 4 feet from the ground. It bore all the year and gave 1,378 oranges by actual count, and it has now 200 on the tree, of all sizes. The tree is very old, I should imagine about 50

26918—Continued.

years, as it is growing in the patio of the house in which I live, and was probably planted when the house was built. I believe this specimen is very hardy and very vigorous and perhaps will make a good stock for budding, where a hardy stock is needed." (*White.*)

26919. Punica protopunica Balf. f.

From Edinburgh, Scotland. Presented by Dr. Isaac Bayley Balfour, director, Royal Botanic Garden. Received March 2, 1910.

See No. 26511 for description.

26920 to 26927.

From Kashmir, British India. Purchased from Mr. Rassul Galwan, Leh, Ladakh, Kashmir. Received January 27, 1910.

Seeds of the following. Unless otherwise noted the seed came from Leh:

26920. Hordeum sp. **Barley.**

Several species are contained in this lot.

26921. Hordeum sp. **Barley.**

26922. Hordeum sp. **Hull-less barley.**

26923. Hordeum vulgare L. **Barley.**

26924. Fagopyrum tataricum (L.) Gaertn. **Buckwheat.**

26925. Panicum miliaceum L. **Proso or broom-corn millet.**

The two preceding numbers are from Nubra, a village north of Leh, where it is warmer.

26926. Brassica campestris L.

26927. Medicago falcata L.

"Mr. Galwan states in substance that this species is valuable, especially for horses. It is seeded in drills 6 inches apart and covered to a depth of 1 inch and immediately irrigated. At least four years are required for the plants to reach their full maturity. The latitude of Leh is 34° 30′ north latitude, 37° east longitude." (*J. M. Westgate.*)

26928. Dahlia coccinea Cav.

From Lawang, Java. Presented by Mr. M. Buysman, Hortus Tenggerensis. Received March 3, 1910.

Flowers single, scarlet, orange, and yellow, plants dwarf. May be valuable for hybridizing with the taller, more showy varieties to obtain dwarf forms.

Distribution.—Southern Mexico; at Santa Fe, near the city of Mexico, at the foot of Mount San Felipe in the Province of Oaxaca, and near Orizaba, in the State of Vera Cruz.

26929. Kennedia stirlingi Lindley.

From Perth, West Australia. Presented by Mr. W. Catton Grasby, agricultural editor, West Australian Mail, through Mr. Charles J. Brand. Received March 4, 1910.

"In experiments conducted by Mr. Grasby this species has given unusual promise as a forage crop. It is a bulky perennial and makes a rapid growth. One of the obstacles to its utilization is its comparative poor seed-producing capacity." (*Brand.*)

Distribution.—The Valley of the Swan River in the southwestern part of West Australia.

26930. FRANKLINIA ALATAMAHA Bartram (*Gordonia pubescens* L'Herit.).

From Philadelphia, Pa. Purchased from Miss Elizabeth De Hart, corner Fifty-fourth and Woodland Avenue. Received March 5, 1910.

"This ornamental is so rarely seen in our gardens that there is some danger of its becoming extinct. It is worthy of a wider distribution and might well be handled by nursery firms." (*Fairchild.*)

Distribution.—Cultivated in the eastern United States as far north as Philadelphia, Pa., and also in western and central Europe.

26931. FRANKLINIA ALATAMAHA Bartram.

From Cheltenham, Pa. Purchased from the Robert B. Haines Company. Received April 14, 1910.

See No. 26930 for previous introduction.

26932. CROTALARIA PUMILA Ortega.

From Miami, Fla. Received through Mr. Edward Simmonds, Subtropical Garden, February 28, 1910.

"This is a perennial species of Crotalaria, native of Miami, Fla. The plant has much the habit and appearance of alfalfa, but is inclined to lodge. The foliage is sweet and palatable, and the plant is worthy of testing in the extreme South for its forage possibilities." (*C. V. Piper.*)

Distribution.—Southern Florida, and in Mexico from Sonora to Vera Cruz, and in the West Indies and Venezuela.

26933 to 26937.

From Buitenzorg, Java. Presented by Mr. A. J. Perkins. Received March 5, 1910.

Seeds of the following; notes by Mr. Perkins:

26933. CITRUS DECUMANA (L.) Murr. **Pomelo.**

"*Jeroek delima.* This is a very good variety of pomelo with pink flesh and few seeds."

26934 and 26935. SAPOTA ZAPOTILLA (Jacq.) Coville. **Sapodilla.**

26934. "Seed from a particularly fine variety."

26935. "Seed from a specially large-fruited variety, as large as a goose egg."

Distribution.—Central America from Yucatan southward to the northern part of South America, and in the West Indies. Cultivated as far north as Lake Worth, Florida, and also in India.

26936. ARTOCARPUS COMMUNIS Forst. **Bread fruit.**

"Seed from a fruit called 'Nangka;' large; spiny coat; yellow pulp."

Distribution.—The islands of the Pacific, and cultivated in India and the West Indies.

26937. SAGUERUS PINNATUS Wurmb.

"Malay name *Kahwoon* or *Ahren.* The young leaves of this palm are much used as wrappers for the Malay cigarettes. The cigarettes have much the appearance of lamplighters and are made from very strong tobacco. Sugar is obtained from the sap of this palm, as the name indicates, and it is used for thatch and for brooms."

Distribution.—Southeastern Asia and the Malayan islands; introduced into the West Indies.

26938. PTERYGOTA ALATA (Roxb.) R. Br.

From Nice, France. Presented by Dr. A. Robertson Proschowsky. Received March 4, 1910.

"The winged seeds of this tree are sometimes eaten by the natives of Burma; according to Roxburgh they are used in Sylhet as a cheap substitute for opium. The wood is light, coarsely fibrous, yellowish white, perishable." (*Watt, Dictionary of the Economic Products of India, vol. 6, pt. 3, p. 361.*)

Distribution.—The western peninsula of India and in the vicinities of Sylhet, Chittagong, Pegu, Martaban, and Tenasserim; also on the Andaman islands.

26939 to 26943. SOLANUM COMMERSONII Dun.

From Berlin, Germany. Presented by Mr. L. Wittmack, Royal School of Agriculture. Received March 4, 1910.

Tubers for use in potato-breeding investigations.

Distribution.—The vicinity of Montevideo, Uruguay.

26944. ZIZANIA LATIFOLIA (Griseb.) Stapf.

From Kew, England. Presented by the Royal Botanic Gardens, at the request of Mr. C. S. Scofield. Received March 3, 1910.

See No. 26760 for description.

26945. QUERCUS DENTATA Thunb.

From the Ming Tombs, near Nan Kou, China. Presented by Mr. F. Bade, through Mr. Hamilton Butler, vice consul-general in charge, Tientsin. Received January 25, 1910.

For previous introductions see Nos. 17842, 17879, and 18265.

Distribution.—Mountain slopes in the provinces of Chihli, Shingking, Shantung, Shensi, and Yunnan, China, in the vicinity of Port Hamilton, Korea, on Green Island, in the Korean Archipelago, and in the vicinities of Hakodate, Simoda, Yokohama, and Yokosuka, in Japan.

26946 to 26948. PHOENIX DACTYLIFERA L. **Date.**

From Panj Chur, Baluchistan. Procured by Mr. John A. Ray, American consul, Maskat, Oman, Arabia. Received January 29 and March 5, 1910.

Seeds of the following; notes by Mr. Ray:

26946. "The best dates; packed in little cases of straw and called '*pish baud*' from pish (straw) and baud (tied); that is, tied in straw."

26947. "Dates packed in a skin. Said to be the kind sold in jars in India. They are called '*mazabti*,' which is said to mean 'cleaned' in Baluchi. On reaching India they are taken from the skins and placed in jars, and they are then known as '*burni*' dates, from burni (meaning jar in Hindustani)."

26948. These dates are better than the preceding numbers. They are packed in jars and are called in the Baluchi language '*hoomb*' (I do not know how they write it). In Arabic they are called 'burni,' meaning jar."

26949. DIOSPYROS KAKI L. f. **Persimmon.**

From Hwai Yuan, via Nanking, China, presented by Dr. Samuel Cochran, American Presbyterian Mission. Received February 26, 1910.

26950. ZEA MAYS L. **Corn.**

From the hacienda of Mr. A. E. Graham, of Forlon, Tamaulipas, Mexico, post-office address Cruz Station, Tamaulipas, Mexico. Procured by Mr. Clarence A. Miller, American consul, Matamoros, Mexico. Received March 8, 1910.

White seeded.

26951 to 26958. ZEA MAYS L. **Corn.**

From Mexico. Procured by Mr. Samuel E. Magill, American consul, Guadalajara, Mexico. Received March 8, 1910.

Seeds of the following; notes by Mr. Magill:

26951. "*Tabloncillo.*" Produced in the vicinity of Zazoalco, Sayula, and Zapotlan.

26952. "*Common.*" Produced near Guadalajara.

26953. "*Common, broad.*" Produced near Guadalajara.

26954. "*Broad.*" Produced near Cocula and some other points.

26955. "*Liso.*" Produced near Ameca.

26956. "*Chino* or *Pepitillo grueso.*" Produced near La Barca.

26957. "*Jala.*" Produced in the Valley of Jala, Territory of Tepic.

26958. "*Cabesoneña.*" Produced near Tequila, and is said to be the superior of any grown in the United States.

26980. PHOENIX DACTYLIFERA L. **Date.**

From the region of El Hasa, Arabia. Procured by Mr. John A. Ray, American consul, Maskat, Oman, Arabia. Received March 25, 1910.

"These dates are called '*khullas*,' meaning pure, extra fine. They have quite a reputation for sweetness, but the original flavor is unfortunately obscured by the addition of cumin seed." (*Ray.*)

26981 and 26982. EUCALYPTUS spp.

From Melbourne, Australia. Presented by Mr. W. R. Guilfoyle, director, Botanic and Domain Gardens. Received March 9, 1910.

Seeds of the following; procured for the Forest Service of this Department, to be used in experimental plantings in the South:

26981. EUCALYPTUS BOTRYOIDES Smith.

26982. EUCALYPTUS SIDEROXYLON A. Cunn.

26983. SAGITTARIA sp. (?)

Procured by Mr. David Fairchild in a Chinese restaurant, Washington, D. C. Received March 9, 1910.

"The *See Koo* is grown extensively around Canton, China, on wet land, very much as the dasheens and taros are grown in other parts of the world. It is to be found for sale on the streets in baskets and special tubs which are carried around by the vegetable dealers. These specimens were given to me by the manager of the Port Arthur restaurant, who informed me that he paid 12 cents a pound for the tubers and that he cut them up and boiled them much as he would potatoes." (*Fairchild.*)

26985 to 26987.

From the Himalayas, India. Presented by J. Mollison, Inspector General of Agriculture in India, Nagpur, India. Received March 10, 1910.

Seeds of the following; notes by Mr. Mollison:

26985. AMYGDALUS PERSICA L. **Peach.**

"Native name *Aru.* A nursery of peach plants is raised in the months of January and February. The land is first dug, properly cleaned, and manured. Seeds are then sown 3 inches deep in trenches and germination takes place in the following March. About a year after, i. e., in February next, the seedlings

26985 to 26987—Continued.

are transplanted to their permanent homes. They are planted in pits dug 2 feet deep, at a distance of 9 feet from each other, and manured with cow or sheep dung. Watering is given every third or fourth day, if necessary. Superior varieties of peaches, apricots, and plums are grafted on these trees."

26986. AMYGDALUS PERSICA L. **Peach.**

"*Nectarine*, another variety of wild peach, native name *Munda Aru*. Same remarks apply to this as to the preceding number (S. P. I. No. 26985)."

26987. PYRUS PASHIA Hamilton.

"Native name *Shegal*. The methods used in raising a nursery and transplanting the seedlings of Shegal plants is the same as that described for peaches (S. P. I. No. 26985). On this tree are grafted superior varieties of pears which are known in the Kulu as '*Nakh*.' No other fruit can be grafted on it."

Distribution.—Temperate slopes of the Himalayas, at an elevation of 2,500 to 8,000 feet, from Kashmir to Bhotan and in the Kashia Mountains, northern India.

26989. CHRYSANTHEMUM STIPULACEUM (Moench) W. F. Wight.

From Yokohama, Japan. Purchased from the Yokohama Nursery Company. Received February 25, 1910.

"Best large mixed."

26990. CICER ARIETINUM L. **Chick-pea.**

From the vicinity of Safed, Palestine. Procured by Mr. Alex. Aaronsohn, Zichron-Jacob, near Haifa, Palestine. Received March 9, 1910.

"Safed is in upper Galilee, at an elevation of 2,000 feet above sea level. The chickpea is cultivated on very calcareous soil; it is sown the end of March and harvested the beginning of July; no rain falls during this time, so that the only moisture it receives is that which is stored in the soil.

"There are three varieties contained in this lot. One, which is considered a botanical variety, has rose-colored flowers and brownish seeds and when cooked turns black; this is a very inferior variety. The other two have white flowers, but one has very small seeds and a thick skin, and requires a long time in cooking; the other is large seeded and is considered better than either of the above-mentioned varieties; it is also much better when cooked." (*Aaron Aaronsohn.*)

26991 to 27000. ZEA MAYS L. **Corn.**

From Mexico. Procured by Mr. William W. Canada, American consul, Vera Cruz. Received March 8, 1910.

Seeds of the following:

26991. From San Cristobal Lave, Vera Cruz Co.

26992. From Hacienda de Tula, Tuxtla Co.

26993. From Cosamaloapan, Cosamaloapan Co.

26994. From Cordoba, Cordoba Co.

26995. From Huatusco, Huatusco Co.

26996. From Huiloapan, Orizaba Co.

26997. From Zongolica, Zongolica Co. (Appears to be mixed.)

26998. From Jalapa, Jalapa Co.

26999. From Papantla, Papantla Co.

27000. From Tlacotalpan, Vera Cruz Co.

27006. TERAMNUS sp.

From San Jose, Costa Rica. Presented by Mr. C. Wercklé, through Mr. H. Pittier. Received March 14, 1910.

"A plant that maintains the fertility of the soil in the cool highlands. It is also a forage plant very much relished by cattle." (*Wercklé.*)

27007 to 27010. VITIS VINIFERA L. **Grape.**

From Guadalajara, Mexico. Presented by Sr. Louis Barbieri, Calle del Carro, No. 27, through Mr. Frederick Chisolm. Received August 22, 1908. Numbered for convenience in recording distribution March 14, 1910.

Cuttings of unnamed varieties.

27011. HYPHAENE GUINEENSIS Schum. (?) **Ivory nut.**

From Grand Bassa, Liberia. Presented by Mr. E. L. Parker, Commissioner of Agriculture, Monrovia, Liberia, at the request of Mr. F. A. Flower. Received March 12, 1910.

"This nut develops at the root of the plant. The natives use the leaves for thatching or covering the roofs of their houses." (*S. G. Harmon.*)

See No. 13136 for previous introduction.

Distribution.—Along the west coast of Africa from the mouth of the Kongo south to the valley of the Kuanza River.

27013. VIROLA SEBIFERA Aubl. **Bicuiba.**

From Bahia, Brazil. Presented by Mr. Omar E. Mueller, American vice consul. Received February 16, 1910.

"The oil from the seed of this tree is used for making candles, and the inner bark is used for medicinal purposes." (*Extract from Engler and Prantl, Natürlichen Pflanzenfamilien, vol. 3, pt. 2, p. 42.*)

Distribution.—Damp woods along streams and on the mountains in Guiana and the valley of the Amazon in Brazil.

27014 to 27016.

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, Government agrostologist and botanist, Transvaal Department of Agriculture. Received March 11 and 12, 1910.

Seeds of the following:

27014. PACOURIA CAPENSIS (Oliver) S. Moore. (*Landolphia capensis* Oliver.)

"This fruit is sometimes called the wild apricot, wild peach, or in Dutch, wilde perske; the Setsu name is 'Maraapa.' It is a low, scrambling shrub common on the kopjes and randjes north of Pretoria, producing an abundance of fragrant white flowers in spring, and numerous large reddish-yellow fruits in January and February. These fruits are edible, with a pleasantly acid flavor, and are said to make good brandy, jelly and vinegar." (*Transvaal Agricultural Journal, April, 1906, p. 617.*)

See 22530 for previous introduction.

27015. XIMENIA CAFFRA Sond. **Kafir plum.**

"This is a small tree, native of the dry bush veldt country at an altitude of about 3,500 feet in districts practically free from frost. The drupe is fairly large, 1 to 1½ inches long, fleshy and very acid, and is much appreciated by the Kafirs. It is said the fruit can be made into excellent jelly." (*Davy.*)

Distribution.—A shrub found in woods in the vicinities of Macallisberg and of Port Natal, in South Africa.

27014 to 27016—Continued.

27016. Vangueria infausta Burch. **Mispel.**

"The 'mispel,' miscalled 'wild medlar,' and known as moupoula or mobola by the natives, is common on kopjes and randjes in the Bosh veldt, and is also met with occasionally on kopjes on the Hoogeveld.

"The fruit of the mispel is sometimes described as the best native fruit of the Transvaal. It has an excellent flavor and is large enough to be worth eating, being over an inch in diameter. The flavor reminds one a little of that of the medlar." (*Transvaal Agricultural Journal, October, 1904, p. 125.*)

See No. 25171 for previous introduction.

27017 to 27019.

From Cape Colony, South Africa. Procured by Mr. Charles P. Lounsbury, Government entomologist. Received March 12, 1910.

Seeds of the following:

27017. Barosma crenulata (L.) Hook. **True buchu.**

See No. 25817 for previous introduction.

27018. Empleurum unicapsularis (L.) Skeels. **False buchu.**

(*Diosma unicapsularis* L. Suppl., pl. 155. 1781. *Empleurum serrulatum* Soland. in Ait on, Hort. Kew., vol. 3, p. 340. 1789.)

This species was referred to the genus Diosma when originally described by Linnæus, but when Solander in 1789, recognizing its generic distinctness, established the genus Empleurum for it he changed the specific designation, as was frequently done in transferring a species from one genus to another. The original specific name has not previously been used in connection with the above generic name.

Distribution.—The extreme southern part of Cape Colony in Africa from mountain valleys in the Tulbagh district eastward to the Zwartberg.

27019. Barosma serratifolia (Curt.) Willd. **Long-leaved buchu.**

Procured through Rev. R. Schmidt, of the Moravian Mission at Genadendal, Caledon.

Distribution.—Mountain slopes in the southern part of Cape Colony.

27020. Pyrus sp. **Pear.**

From St. Anthony Park, St. Paul, Minn. Presented by Prof. Samuel B. Green, Division of Horticulture and Forestry, University of Minnesota. Received March 14, 1910.

"Plants grown from seed received from Professor Parker, Manchuria." (*Green.*)

27025. Picea obovata schrenkiana (Fisch. and Mey.) Carr.

From Orleans, France. Purchased from Messrs. Barbier & Co. Received March 16, 1910.

"This variety is closely related in appearance to *Picea excelsa*, but it differs from it in the bracts at the base of the cones, which are much longer, and in its leaves, which are farther apart, thicker, and longer, often 25 to 30 mm. The cones are cylindrical, 8 cm. long by 22 mm. in diameter. Here (Paris), the plants are bushy; the branches generally frail, spreading, deflected, and although it comes from the cold parts of Europe, is, nevertheless, delicate, grows badly, and often freezes, being injured by the spring frosts, which come after they have started to grow. This form particularly,

27025—Continued.

which comes out very early in the springtime, freezes almost every year." (*Extract from Carrière, Traité générale des Conifères, p. 338.*)

See No. 22909 for previous introduction.

Distribution.—The slopes of the Alatau Mountains in southern Siberia, and the Tien Shan Mountains in Dzungaria, in the western part of the Chinese Empire. (Plants.)

27026. MEDICAGO SATIVA L. **Alfalfa.**

From Gabes, Tunis. Procured by Mr. M. Victor Dumas, Controleur Civil, Sousse, Tunis, from El Habib ben Trab, Amin des vivres á Menzel, for Mr. J. M. Westgate, at the suggestion of Mr. T. H. Kearney. Received March 12, 1910.

Tripoli.

27027. OLEA EUROPAEA L. **Olive.**

From the foothills of the Amanus Mountains, Turkey. Presented by Mr. F. D. Shepard, Aintab, Turkey. Received March 11, 1910.

"These olives were collected on the landward side of the Amanus Mountains, where the climate is semiarid. The olive is more at home on the seaward side of these mountains, where the tree, or shrub (for in the wild state it is more like a shrub than a tree) is larger and the fruit nearly twice as large. It does not grow wild on the Kurd Dagh (Kurdish Mountains), the parallel range farther inland, and still more arid, although the cultivated olive thrives there." (*Shepard.*)

27028 to 27031.

From Baumschulenweg, bei Berlin, Germany. Purchased from Mr. L. Späth. Received March 17, 1910.

Plants of the following; descriptions taken from Späth's catalogue for 1909–10:

27028 to 27030. SORBUS AUCUPARIA L. **Mountain ash.**

27028. "Variety *moravica* Zengerling. From northern Austria. The fruits are put up like red whortleberries and make a very refreshing preserve; they can also be used in the making of wine. The scarlet-red berries are larger than the Russian ones, but decidedly sharper in taste. The tree thrives on the poorest soil."

27029 and 27030. "According to information from a Russian business friend, these edible mountain ashes are much cultivated in southern Russia, partly eaten fresh, but more used in the preserve manufactory at Kief. The berries, the size of peas, are powdered with sugar, dried, and shipped in boxes. I tasted these fruits prepared in this way and found that they had a pleasantly acid taste, a little bitter, but not at all unpleasant. The fruits are used as dessert fruits, for the making of tarts, etc., and like the Moravian edible mountain ashes, make a very nice preserve. Found in two forms as follows:

27029. "Variety *rossica* L. Späth, 1898.

"Berries the size of the ordinary mountain ash, round, coral red. Taste acid sweet, slightly astringent, but without any bitter aftertaste."

27030. "Variety *rossica major* L. Späth, 1903.

"Berries somewhat larger than those of the preceding form (S. P. I. No. 27029), short, oval, scarlet red, without any bitter taste."

27028 to 27031—Continued.

27031. × Prunus dasycarpa Ehrh. **Plum-apricot.**

Considered to be a hybrid between *Prunus cerasifera myrobalana* and *P. armeniaca.*

"This tree has white blooms in the early spring, and the fruit ripens at the beginning of August. It is medium sized, blackish purple, with fine hairs; the flesh is blood red, turning to orange near the stone, juicy, sweet, and of apricot taste."

27032 and 27033. Citrus spp.

From Tanable, Wakayamaken, Japan. Presented by Mr. Sietaro Matsuba, at the request of Mr. A. J. Perkins. Received March 14, 1910.

27032. Citrus aurantium L. **Orange.**

Natsu-mikan. See No. 22670 for description. (Cuttings.)

27033. Citrus sp.

Uchi murasaki. (Seeds.)

27034. Diospyros kaki L. f. **Persimmon.**

From Gifu, Japan. Procured from the Gifu Agricultural Experimental Station, through the Yokohama Nursery Company, Yokohama, Japan, at the suggestion of Mr. A. J. Perkins. Received March 9, 1910.

Suyugaki. (Plants.)

27035 to 27042. Diospyros kaki L. f. **Persimmon.**

Presented by Rev. H. Loomis, American Bible Society, Yokohama, Japan. Received February 21, 1910.

Cuttings of the following:

27035–27041. From Sendai, Japan, 237 miles from Yokohama, 217 miles north of Tokyo.

27035. *Tsurunoko.* (Ana.)

27036. *Tanenashi.* (Shibu.)

27037. *Hachiya.* (Shibu.)

27038. *Heyakume.* (Ana.)

27039. *Hegaki.* (Shibu.)

27040. *Toyama.* (Shibu.)

27041. *Okame.* (Shibu.)

"Nos. 27035 and 27038 are not astringent."

27042. From Korea. "This fruit is not astringent and is of excellent flavor. It grows in a climate that is like that of Philadelphia." (*Loomis.*)

27043. Diospyros kaki L. f. **Persimmon.**

From Tokyo, Japan. Procured by Rev. H. Loomis, American Bible Society, Yokohama, Japan, from the garden of Count Date. Received March 12, 1910.

"I think these persimmons are of rare value, being very sweet, not astringent, quite large, and almost seedless, probably a distinctly new variety." (*Loomis.*)

27044. Dioscorea alata L. **Yam.**

From Miami, Florida. Grown at the Subtropical Garden, sent in by Mr. P. J. Wester. Received March 15, 1910.

"One of the most promising of the yams." (*Wester.*)

27045 to 27048.

From Orleans, France. Presented by Mr. Leon Chenault, at the request of Mr. Philippe Vilmorin.
Received March 14, 1910.

Plants of the following:

27045. × Berberis stenophylla Lindl.

"Seedlings of this hybrid between *B. darwinii* and *B. empetrifolia.* The seedlings break up in all intermediate types and the whole plant serves as an excellent illustration that even if the immediate result of a hybridization does not give what is wanted, the seedlings of such a plant may." (*F. N. Meyer.*)

27046. Pinus armandi Franch.

"A new rather dwarf pine from western China." (*F. N. Meyer.*)

Distribution.—On the Tsingling Mountains in the Province of Shensi, and in the Provinces of Szechwan and Yunnan, western China.

27047. Lonicera pileata Oliver.

"This is a good plant for rockeries and at the ends of beds of shrubbery; it is of cespitose habit like the *Cotoneaster horizontalis.*" (*F. N. Meyer.*)

Distribution.—Only known from the vicinity of Ichang in the Province of Hupeh, China.

27048. Morus alba L. **White mulberry.**

"Variety *fastigiata.* Quite rare, and may be of value in the Southern States as a pyramidal tree." (*F. N. Meyer.*)

27049 to 27072.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, March 12, 1910.

Cuttings of the following:

27049 to 27057. Punica granatum L. **Pomegranate.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 421 to 429, February 10, 1910.) A collection of named pomegranates obtained from the experimental station near Sukhum. As the plants were only recently received at the station, no definite information could be obtained regarding them at present." (*Meyer.*)

27049. "*Krylezy-Kabuk.* (No. 421.)"

27050. "*Seville a gros grain.* (No. 422.)"

27051. "*Alopar.* (No. 423.)"

27052. "*Sushinski rannyi.* (No. 424.)"

27053. "*Di Brindishi.* (No. 425.)"

27054. "*A frutto grosso.* (No. 426.)"

27055. "*Yelisavetpolski sladkii.* (No. 427.) A large-fruited variety having red flesh and of sour taste. A local Caucasian variety, obtained originally from the vicinity of Yelisavetpol (Caucasus)." (*Meyer.*)

27056. "*Shirinar.* (No. 428.)"

27057. "*Nain des Antilles.* (No. 429.)"

27058. Citrus medica L. **Lemon (?)**

From near Sukhum-Kale, Caucasus, Russia. "(No. 435, February 11, 1910.) A large-fruited lemon, very juicy, and with few seeds. Has proved to be a heavy fruiter and to be more frost resistant than any other lemon in this locality. Found originally among a bunch of other citrus stock in the garden of Mr. Smitskoi, near Sukhum, where these cuttings were obtained." (*Meyer.*)

27049 to 27072—Continued.

27059. Prunus sp. **Plum.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 436, February 10, 1910.) A native plum, from the Caucasus, of bluish color, medium size, found wild in the mountains but also sparingly cultivated by the natives. Probably suitable for the Gulf region and for northern Florida. Obtained from the Experimental Station near Sukhum." (*Meyer.*)

27060. Malus sylvestris Mill. **Apple.**

From Dioscuria, near Sukhum-Kale, Caucasus, Russia. "(No. 437, February 16, 1910.) A native variety of apple, generally called *Afghasian* apple, grown by the natives for centuries. The fruits are large, of a grayish-green color except on the side exposed to the sun, where they are adorned with narrow, vertical, red stripes; of a fresh, sour taste; picked from the trees in the latter part of October or early November, they have to lie some time before being ripe; can be kept until late in spring. A good apple for the warmer sections of the United States and especially for the Gulf region. The young trees of this variety of apple are characterized by the very upright growth of the branches and the clean bark; when the trees get to be older, however, they become spreading and the bark begins to be rough. In the Caucasus, this variety is not very quickly attacked by woolly aphis, but when once this pest gets a hold on them, they become full of lumps and knots like the ordinary European varieties." (*Meyer.*)

27061. Malus sylvestris Mill. **Apple.**

From Dioscuria, near Sukhum-Kale, Caucasus, Russia. "(No. 438, February 16, 1910.) A Circassian apple indigenous to the Caucasus, said to be very fine, obtained originally from a native prince. Fit for the mild-wintered regions of the United States." (*Meyer.*)

27062. Pyrus communis L. **Pear.**

From Dioscuria, near Sukhum-Kale, Caucasus, Russia. "(No. 439, February 16, 1910.) A very early ripening variety of pear, called '*Duchesse de Sukhum.*' Of medium size and melting taste, ripens in June. Probably a good variety for the Southern States and especially the Gulf region." (*Meyer.*)

27063. Pyrus communis L. **Pear.**

From Dioscuria, near Sukhum-Kale, Caucasus, Russia. "(No. 440, February 16, 1910.) A variety of pear locally known as the '*Turkish pear.*' Fruits medium large, of beautiful shape, ripening in August. Trees very strong growers when young and producing heavy crops. Probably a good variety for the mild-wintered regions of the United States." (*Meyer.*)

27064. Morus alba L. **White mulberry.**

From Dioscuria, near Sukhum-Kale, Caucasus, Russia. "(No. 452, February 16, 1910.) Variety *tortuosa.* A strange ornamental mulberry, having branches that run zigzag. Of use as a decorative garden tree in regions where the winters are mild and the summers hot and dry." (*Meyer.*)

27065. Olea europaea L. **Olive.**

From Sukhum-Kale, Caucasus, Russia. "(No. 454, February 17, 1910.) A very large-fruited variety of olive, named '*Cucchi,*' bears black fruits the size of a small plum. Although the climate of this part of the Caucasus is rather unsuited to olives, being too moist, this variety fruits regularly here. Obtained from the Botanical Garden at Sukhum-Kale." (*Meyer.*)

27049 to 27072—Continued.

27066. CITRUS AURANTIUM SINENSIS L. **Orange.**

From Sukhum-Kale, Caucasus, Russia. "(No. 455, February 17, 1910.) A seedling orange, originated at the Botanical Garden at Sukhum-Kale. Of very strong growth, somewhat spiny, especially on strong shoots. Fruits medium sized, not over sweet and with rather numerous seeds. The trees, however, are hardier here in this locality of the Caucasus than any other variety according to Mr. A. Van de Velde, the head gardener in charge of the Botanic Garden, from whom these cuttings were obtained." (*Meyer.*)

27067. CITRUS AURANTIUM SINENSIS L. **Orange.**

From Sukhum-Kale, Caucasus, Russia. "(No. 456, February 17, 1910.) A seedling orange, originated a few years ago in the garden of Mr. Shwetsoff, at Sukhum-Kale. Fruit large, juicy, and sweet, with few seeds. Trees of medium-strong growth, with very dark-green foliage. Quite hardy in this part of the Caucasus. Obtained from the same source as No. 455 (S. P. I. No. 27066) and, like it, may be tested in the northern limits of successful orange culture in the United States." (*Meyer.*)

27068. PRIMULA VULGARIS Hill. **Primrose.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 457, February 10, 1910.) Variety *sibthorpii*. A beautiful wild primrose growing along moist embankments, producing masses of rather large flowers of a very beautiful purplish-blue color. A handsome spring-flowering plant for the mild-wintered sections of the United States." (*Meyer.*)

27069. FRAGARIA sp. **Strawberry.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 458, February 10, 1910.) A wild strawberry, occurring here and there along embankments, open woodlands, and even in dry calcareous cliffs. Flowers in early February and sometimes produces ripe fruits at the end of February; these fruits are said to be small but sweet. I suggest that this strawberry be used as a factor in creating a more drought and heat resistant strain of this favorite fruit than we have at the present." (*Meyer.*)

27070. VIOLA sp. **Violet.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 459, February 10, 1910.) A wild violet occurring at the edges of woodlands and on open places. Has large flowers of a beautiful dark-violet color, not very fragrant. Of value as an ornamental garden perennial in the mild-wintered sections of the United States and as an element in breeding more heat-resistant strains of this flower." (*Meyer.*)

27071. FICARIA sp.

From near Sukhum-Kale, Caucasus, Russia. "(No. 460, February 16, 1910.) A Ficaria in looks and habits between *F. ranunculoides* and *Caltha palustris*. Found growing in moist, open woodlands; flowers in February; the individual flowers often measure more than an inch in diameter, are of a bright-yellow color and stand out above the shining foliage. Recommended as an ornamental spring-flowering plant in the mild-wintered sections of the United States." (*Meyer.*)

27072. MEDICAGO sp.

From near Sukhum-Kale, Caucasus, Russia. "(No. 461, February 7, 1910.) Plants found in earth cliffs. To be tested in a mild climate." (*Meyer.*)

27073 to 27082. Zea mays L. **Corn.**

From Mexico. Procured by Mr. Arnold Shanklin, American consul, Mexico City, Mexico. Received March 11, 1910.

Seeds of the following:

27073. From Puebla. Grown on the property of Mr. Pablo Petersen. Height of stalk, 19½ feet. Yield 135 bushels per acre.

27074. From Valley of Mexico. Black seeded.

27075. From Oaxaca. Yellow seeded.

27076. From Oaxaca. White seeded.

27077. From Oaxaca. Black seeded.

27078. From Puebla, District of Chalchicomula.

This has a small cob. Grows in a cold climate, at an altitude of 8,000 feet.

27079. From Oaxaca. Mixed corn.

27080. From Puebla, District of Matamoras.

Dry, hot climate.

27081. From Guanajuato. Grown near Silao.

27082. Note.—The corn listed under this number was of three different varieties, the tags had become detached and the ears were mixed. The notes on the tags were as follows:

From Valley of Mexico.
From City of Puebla. Yield 76 bushels per acre. Matures in 6 months.
From near City of Puebla. Yield 40 bushels per acre.

27086 to 27088. Diospyros kaki L. f. **Persimmon.**

From Okitsu, Japan. Presented by Dr. Ouda, at the request of Mr. A. J. Perkins. Received March 19, 1910.

Cuttings of the following:

27086. *Fuyu.*

27087. *Jiro.*

27088. *Yokono.*

27089 to 27095.

From Gagri, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, March 17, 1910.

Cuttings and plants as follows:

27089. Philadelphus sp.

From near Gagri, Caucasus, Russia. "(No. 405, February 2, 1910.) A mock orange, found on stony mountain slopes and in cliffs. Apparently very floriferous. Of value as an ornamental flowering shrub in mild-wintered regions." (*Meyer.*)

27090 and **27091.** Medicago sp.

From near Gagri, Caucasus, Russia. "(No. 413 and 414, January 31, 1910.) Alfalfas growing on the south side of cliffs. Apparently several species among this lot. As the winter in this part of the Caucasus is very mild these plants will probably not be able to stand any hard frost." (*Meyer.*)

27092. Melilotus sp.

From near Gagri, Caucasus, Russia. "(No. 416, January 31, 1910.) Found along a road in stony débris; perhaps of value as a fodder plant." (*Meyer.*)

27089 to 27095—Continued.

27093. PSORALEA sp.

From near Gagri, Caucasus, Russia. "(No. 417, January 31, 1910.) Found growing on dry places in decomposed rock. This legume may be of value as a fodder plant in mild-wintered regions where hot summers prevail." (*Meyer.*)

27094. VINCA sp.

From near Gagri, Caucasus, Russia. "(No. 418, January 31, 1910.) A Vinca found in shady nooks in the mountains, often hanging down between rocks. Apparently distinct from the ordinary *Vinca major.* Of value as a ground cover or basket plant in mild-wintered regions." (*Meyer.*)

27095. (Undetermined.)

From near Gagri, Caucasus, Russia. "(No. 420, February 1, 1910.) A grass growing plentifully here and there between bowlders and rocks on mountain sides. Perhaps of value as a fodder grass in mild-wintered regions." (*Meyer.*)

27097 and 27098. PYRUS spp.

From Kew, England. Presented by Dr. David Prain, director, Royal Botanic Garden. Received March 21, 1910.

Cuttings of the following:

27097. PYRUS CHINENSIS Lindl. **Sand pear.**

27098. PYRUS SIMONI Carr.

Distribution.—The Provinces of Chihli, Shingking, and Kiangsi, in China, and in Korea, Manchuria, and Japan.

27099. RAVENSARA AROMATICA Sonner.

From Port Louis, Mauritius. Presented by Mr. G. Regnard. Received March 14, 1910.

"A fairly interesting spice tree." (*Regnard.*)

This species of Ravensara is a large, bushy tree with a pyramidal head, entire leaves, small flowers, and pear-shaped fruits the size of a small hickory nut. The leaves and fruit are prepared by rolling into a ball which is allowed to hang in the air for a month; then placed in boiling water for five minutes, and afterwards dried in the sun or before a fire. This process preserves the leaves and fruits so that they keep for several years. (*Adapted from Sonnerat, Voyage aux Indes Orientales, vol. 2, p. 226.*)

Distribution.—The island of Madagascar.

27101 to 27105. MEDICAGO SATIVA L. **Alfalfa.**

From Victoria, Minn. Obtained by Mr. J. M. Westgate from the farm of Mr. Henry Gerdsen, August 11, 1909. Numbered for convenience in recording distribution March 21, 1910.

"These five selected plants were presumably 40 years old, as the field from which they were taken was seeded in 1868 or 1869, according to Mr. Gerdsen, and there has been no apparent reseeding since. The crowns of all the plants were very large and apparently uniform in age; the individual crowns were often 2 feet in diameter and were occasionally broken up into two or more separate but adjacent plants." (*Westgate.*)

27106. CARICA PAPAYA L. **Papaya.**

From Bangalore, Mysore, India. Presented by Rev. N. L. Rockey, Gonda, United Provinces, India. Received March 21, 1910.

Seed supposedly of this same variety received under No. 25692.

27107 to 27111.

Presented by Mr. E. C. Parker, agriculturist, Bureau of Agriculture, Industry and Commerce, Mukden, Manchuria. Received March 19,1910.

Seeds of the following; descriptive notes by Mr. Parker:

27107. Prunus sp. **Cherry.**

"Chinese name *Ying tao.* Common in the hills of Manchuria as far north as 44° to 45° north latitude. Growth resembles the sand cherry of America, almost shrubby. Sometimes attains a height of 10 feet. Fruit borne along main stalks similar to sand cherry and gooseberry. Valuable in America for ornamental purposes, for grafting, and for cookery. The fruit is tart and well flavored."

27108. Malus sp. **Crab apple.**

"Chinese name *Shan ting tsze.* Common in the hills of Manchuria as far north as 44° to 45° north latitude. Very hardy and healthy growth. Fruit about one-half to three-fourths inch in diameter, resembling a thorn apple. Trees attain a height of 10 to 15 feet. Valuable in America for grafting purposes only."

27109. Prunus armeniaca L. **Apricot.**

"Chinese name *Hing.* Common in the hills of Manchuria as far north as 43° north latitude. A small, spreading tree. Fruit small and fibrous, poor quality. Valuable in America for grafting and budding purposes only."

27110. Amygdalus persica L. **Peach.**

"Chinese name *Tao.* Same description as the preceding (S. P. I. No. 27109)."

27111. Amygdalus persica L. **Peach.**

"Chinese name *Ta po tao.* A large white peach, native in Shantung Province, China (Chefoo district). Quality of fruit, fair; growth of tree not known."

27112 to 27150.

From Kew, England. Presented by Dr. David Prain, director, Royal Botanic Gardens. Received February 4, 1910.

Seeds of the following:

27112. Actaea rubra (Ait.) Willd.

Distribution.—Nova Scotia to New Jersey and Pennsylvania, and west to the Rocky Mountains.

27113. Aronia arbutifolia (L.) Pers.

Distribution.—In swamps and wet woods, from Nova Scotia to Minnesota, and south to Florida and Louisiana.

27114. Aronia melanocarpa (Michx.) Ell.

Distribution.—In swamps and low woods, or occasionally on rocks, from Nova Scotia to Florida, and west to Michigan.

27115. Berberis angulosa Wall.

Distribution.—The temperate slopes of the Himalayas, at an altitude of 11,000 to 13,000 feet, in the Provinces of Nepal and Sikkim, northern India.

27116. Berberis aristata DC.

Distribution.—Temperate slopes of the Himalayas, at an altitude of 6,000 to 10,000 feet, between Bhotan and Kunawar; also in the Nilgiri Hills in southern India, and in the mountains of Ceylon, at an altitude of 6,000 to 7,000 feet.

27112 to 27150—Continued.

27117. BERBERIS CONCINNA Hook. f.

Distribution.—Interior valleys of the Himalayas, at an elevation of 12,000 to 13,000 feet, in the Province of Sikkim, northern India.

27118. BERBERIS DICTYOPHYLLA Franch.

Distribution.—Slopes of the mountains in the Province of Yunnan, southern China, at an elevation of 10,000 feet.

27119. BERBERIS PACHYACANTHA Koehne.

Distribution.—Slopes of the Himalayas, at an altitude of 10,000 feet, in the Province of Kashmir, northern India.

27120. BERBERIS THUNBERGII DC.

Distribution.—Slopes of the mountains on the island of Kiushu, Japan. Generally cultivated as an ornamental.

27121. BERBERIS UMBELLATA Wall.

Distribution.—Temperate slopes of the Himalayas at an elevation of 9,000 to 11,000 feet, from Kumaon to Bhotan, India.

27122. BERBERIS VIRESCENS Hook. f.

Distribution.—Slopes of the Himalayas at an elevation of 9,000 feet, in the provinces of Sikkim and Bhotan, northern India.

27123. MALUS MEDWIETZKYANA Dieck.

NOTE.—These seeds were received under the name *Pyrus niedzwetzkyana.* The first name given to this apple, *Malus medwietzkyana,* appears in the Neuheiten-Offerte des National-Arboretums zu Zoeschen bei Merseburg, for 1891, page 16. Dr. Dieck here states that it was collected by "Herrn Gerichtspraisidenten Medwietsky." In the same catalogue for 1892–3, Dr. Dieck gives the collector's name as "Herrn Gerichtspraisidenten Niedzwetsky," and calls the apple "*Malus niedzwetzkyana.*" Being trade catalogues, a description printed therein is not considered as botanical publication of these names. Another notice of this apple appears in the Wiener Garten Zeitung for April, 1891, page 164. Here, under the name *Malus Medwietzkyana,* are given the statements found in Dieck's 1891 catalogue, and the description being sufficient for identification, it is regarded as the place of botanical publication. Also, in the Gardeners' Chronicle for April 11, 1891, page 461, under the name *Malus medwietzkyana,* the same notes and descriptions are given, evidently taken from Dieck's catalogue.

Koehne, Deutsche Dendrologie 259, 1893, under *Malus paradisiaca,* mentions *M. niedzwetzkyana,* stating that he is not sure it is a form of *M. paradisiaca.* Hemsley, Curtis's Botanical Magazine, plate 7975, 1904, under the name *Pyrus niedzwetzkyana,* gives a figure and a detailed description of the plant and cites all the above-mentioned publications. Regarding the specific name he remarks: "As to the spelling of the distinctive name, we have adopted the one used by the author in his second account of the plant, where, however, he gives no explanation of the deviation from the first."

As to the correct spelling of the name of Dr. Dieck's patron, Mr. A. V. Babine, assistant in charge of the Slavic section of the Library of Congress, in reply to an inquiry as to the correct spelling of the name, states: "I have looked up the name you mention. The second form given by you (Medwietzky) is more nearly correct." There seems, therefore, to be no reason for the change of spelling adopted by Hemsley, and the correct name for this apple remains *Malus medwietzkyana,* as first used by Dieck and as published in the Wiener Garten Zeitung, above cited. (*H. C. Skeels.*)

27112 to 27150—Continued.

Distribution.—The valley of the Kashgar River in eastern Turkestan, both wild and cultivated, and also cultivated throughout southwestern Siberia and central Asia.

27124. Malus prunifolia (Willd.) Borkh.

Distribution.—Considered by some authors to be a hybrid between *Malus sylvestris* and *M. baccata*, probably arising in Siberia.

27125. Malus ringo Sieb.

Distribution.—Central Japan, especially in the vicinity of Fujiyama Mountain.

27126. × Malus scheideckeri Spaeth.

A hybrid of garden origin between *Malus floribunda* and *M. prunifolia.*

27127. Malus sikkimensis (Hook.) Koehne.

Distribution.—Slopes of the Himalayas in the province of Sikkim, northeastern India.

27128. Malus toringo Sieb.

Distribution.—Originally from Japan; cultivated in European and American gardens as an ornamental tree.

27129. Pyrus balansae Decaisne.

Distribution.—Wooded slopes of the hills in the province of Laristan, southern Persia, at an elevation of 5,200 feet.

27130. × Pyrus irregularis Moench.

Distribution.—A hybrid between *Pyrus communis* and *Sorbus aria,* arising in a garden in France, and first described by Bauhin in the year 1650.

27131. Pyrus longipes Coss. and Dur.

Distribution.—Forests on the slopes of the Atlas Mountains in the province of Batna and on the Aures Hills in western Algeria.

27132. Pyrus michauxii Bosc.

Probably a hybrid between *Pyrus amygdaliformis* and *P. nivalis.*

27133. Pyrus nivalis Jacq.

Distribution.—Slopes of the mountains in southern Germany, France, and northern Italy, and in the Austrian Alps.

27134. Pyrus nivalis elaeagrifolia (Pall.) Schneider.

Distribution.—Throughout Asia Minor and in Armenia.

27135. Pyrus sinai Desf.

Distribution.—The slopes of Mount Sinai, Arabia.

27136. × Sorbus alpina (Willd.) Heynh.

This form is supposed to be a hybrid between *Sorbus aria* and *Aronia arbutifolia.*

27137. Sorbus americana Marsh.

Distribution.—Mountain slopes from Labrador to North Carolina and west to Michigan.

27138. Sorbus aria graeca (Lodd.) Boiss.

Distribution.—Slopes of the mountains in Greece, Crete, Crimea, and Syria.

27139. Sorbus aucuparia lanuginosa (Kit.) Beck.

Distribution.—This form occurs with the species in the south-central and southeastern part of Europe.

27112 to 27150—Continued.

27140. × Sorbus heterophylla (Du Roi) Reichenb.

This form is supposed to be a hybrid between *Sorbus aucuparia* and *Aronia arbutifolia.*

27141. × Sorbus latifolia (Lam.) Pers.

Distribution.—Considered to be a hybrid between *Sorbus torminalis* and *S. aria,* arising in the forests of Fontainebleau, France.

27142. Tricholaena rosea Nees.

Distribution.—Throughout tropical Africa and extending south to the Cape; also Madagascar and in southern Arabia.

27143. Trifolium johnstoni Oliver.

Distribution.—The slopes of Mount Kilimanjaro at an elevation of 10,000 feet, in the southern part of British East Africa.

27144. Trifolium scabrum L.

Distribution.—Dry, stony, and grassy places in central Europe, extending from Holland, Belgium, and the eastern provinces of France, through Germany, Switzerland, and Austria, to Bosnia and Montenegro.

27145. Trifolium perreymondi Gren.

Distribution.—Apparently known only from the vicinities of Roquebrune and Frejus in the province of Var, southeastern France.

27146. Trigonella coerulea (L.) Ser.

Distribution.—The mountain slopes of the northern part of Spain, the southern provinces of Russia, and in the region of the Caucasus Mountains.

27147. Trigonella corniculata L.

Distribution.—The countries along the Mediterranean from Spain and southern France through Italy and Greece to Asia Minor and in northern Africa.

27148. Trigonella cretica Boiss.

Distribution.—The island of Crete, and in Asia Minor and northern Africa.

27149. Trigonella ovalis Boiss.

Distribution.—Southern Spain, sandy banks of the Guadalhorce River in the province of Malaga, and in waste places near cultivated fields in the vicinity of Riopar, province of Murcia.

27150. Trigonella polycerata L.

Distribution.—Borders of cultivated fields and waste places in central and northern Spain and in northern Africa; introduced into France in the vicinity of Marseille; and near Verviers, Belgium, and Darmstadt, Germany.

27151 to 27157.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, March 19, 1910.

Cuttings of the following:

27151. Malus sylvestris Mill. **Apple.**

From near Kopetnari, Caucasus, Russia. "(No. 462, March 1, 1910.) A yellow winter apple of medium size and fairly firm flesh. The trees are able to stand high summer temperatures, but require mild winters. Obtained from a native Mingrelian orchard. To be tested in the southern sections of the United States." (*Meyer.*)

27151 to 27157—Continued.

27152. Malus sylvestris Mill. **Apple.**

From near Kopetnari, Caucasus, Russia. "(No. 463, March 1, 1910.) A red apple, said to be large and fine looking. For other remarks see preceding number (S. P. I. No. 27151.)" (*Meyer.*)

27153. Malus sylvestris Mill. **Apple.**

From near Kopetnari, Caucasus, Russia, "(No. 464, March 1, 1910.) A white apple said to grow very large; according to a native fruit grower, some fruits weigh several pounds each. For other remarks see preceding numbers (S. P. I. Nos. 27151 and 27152.)" (*Meyer.*)

27154. Prunus avium L. **Cherry.**

From near Kopetnari, Caucasus, Russia. "(No. 465, March 1, 1910.) A sweet, white cherry, having large fruits and ripening in early June. Able to stand high summer temperatures. Said to be a very fine variety. Obtained from a native Mingrelian orchard." (*Meyer.*)

27155. Prunus avium L. **Cherry.**

From near Kopetnari, Caucasus, Russia. "(No. 466, March 1, 1910.) A sweet, white cherry ripening in early June, fruits not as large as those of the preceding number (S. P. I. No. 27154). Obtained from a native Mingrelian orchard." (*Meyer.*)

27156. Prunus avium L. **Cherry.**

From near Kopetnari, Caucasus, Russia. "(No. 467, March 1, 1910.) A sweet, red cherry, ripening very early, the end of April or beginning of May. Fruit not very large, but popular on account of its earliness. For other remarks see No. 465 (S. P. I. No. 27154)." (*Meyer.*)

27157. Prunus avium L. **Cherry.**

From Quirili, Caucasus, Russia. "(No. 468, March 1, 1910.) A sweet, black, early, native Caucasian variety of cherry, ripening toward the end of May and able to stand high summer temperatures." (*Meyer.*)

27158. Solanum jamesii Torr. **Potato.**

From Prescott, Ariz. Presented by Mr. Daniel Hatz. Received March 23, 1910. "Tubers of a native potato, grown in old willow land, without irrigation." (*Hatz.*)

Distribution.—On the slopes of the mountains at an elevation of 4,000 to 7,000 feet, from Colorado southward to Texas and Arizona.

27159 and 27160.

Presented by Mr. O. W. Barrett, Director of Agriculture, Lourenço Marquez, Portuguese East Africa. Received March 21, 1910.

Seeds of the following:

27159. Bauhinia monandra Kurz. (?)

From Deli, Portuguese Timor, East Indies. "(No. 32, February 18, 1910.) Ornamental shrub. Pod 20 to 22 cm. long. Probably new or very rare in America. Adapted to California, Gulf States, Porto Rico, etc." (*Barrett.*)

27160. Adansonia digitata L.

From territory of Tete, Zambesia, Portuguese East Africa, "(No. 33, February 18, 1910.) Shisena name '*Chiwooia.*' One of the largest if not the very largest variety (species?) of African Baobab, or 'Cream-of-Tartar' tree. Height 15 to 25 meters; diameter 2 to 10 meters. A most striking tree for frostless regions." (*Barrett.*)

27159 to 27160—Continued.

Distribution.—The Senegambia region in upper Guinea on the west coast of Africa, and along the eastern coast from Abyssinia south to the Mozambique district. Cultivated in India and Ceylon.

"This is the famous Baobab or Monkey-bread tree, known also in India as the Cork tree. The trunk attains a height of 40 to 60 feet and a diameter of 30 feet. Its bark furnishes cordage, and the pulp of the fruit is slightly acid and refrigerant." (*Oliver, Flora Tropical Africa, vol. 1, p. 213.*)

27161 to 27163.

From Algeria. Presented by Dr. L. Trabut, Algiers, Algeria. Received March 14 and 18, 1910.

Seeds of the following:

27161. ANDROPOGON SORGHUM (L.) Brot. **Durra.**

"Variety *tinctorium*. Used for coloring hides red, at Insalah, in Arabia Tafsut hamra." (*Trabut.*)

"I have compared this with G. I. No. 103 which was received directly from Dr. Trabut in 1904. It originated on the Oasis de Couat, below 30° north latitude. The two varieties though both durras, are not closely related. The long, rather thin, reddish glumes of No. 27161, and the medium-sized, obovate, yellowish-white seeds are quite different from the leathery, black glumes and very large seeds of G. I. No. 103." (*Carleton R. Ball.*)

27162. ZIZIPHUS LOTUS (L.) Lam.

See No. 21995 for previous introduction.

27163. ASPARAGUS STIPULARIS Forsk.

Distribution.—In dry places along roads and in vineyards, in Portugal and southern Spain, in Sicily, the Canary Islands, and in the northern part of Africa.

27164. STIZOLOBIUM sp.

From Yokohama, Japan. Purchased from the Yokohama Nursery Company. Received March 22, 1910.

27165. ROSA sp. **Rose.**

From Shanghai, China. Presented by Rev. J. M. W. Farnham. Received March 15, 1910.

"Cuttings from bushes growing wild on the mountain. It is a rambler, and, from the description, seems to me to resemble the *Cherokee.*" (*Farnham.*)

27166 to 27170.

From Buitenzorg, Java. Presented by the Director of the Botanic Garden. Received March 21, 1910.

Seeds of the following:

27166 to 27168. NEPHELIUM LAPPACEUM L. **Ramboetan.**

27166. Variety *si matjan.*

27167. Variety *sinjouja.*

27168. Variety *lebak boeloes.*

See Nos. 25163 to 25165 for description.

27169. DURIO ZIBETHINUS Murr.

Distribution.—The Malayan Islands; cultivated in the Malay Peninsula.

27166 to 27170—Continued.

27170. Artocarpus integra (Thunb.) L. f. [*integrifolia*].

The earliest spelling, 1776, of the specific name is *integra* as given above, the change to *integrifolia* having been made by Linnæus f. in 1781.

Distribution.—Cultivated throughout the warmer parts of India and eastern Asia; probably native in the forests of the Western Ghats in India.

27172 to 27193.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, March 4, 1910.

Seeds of the following:

27172. Olea europaea L. **Olive.**

From Nikita, Crimea, Russia. "(No. 1236a, January 24, 1910.) Collected from trees that have successfully withstood freezes of 15° Reaumur below zero (about $-2°$ F.). To be tested in the regions recommended for Nos. 388 to 398 (S. P. I. Nos. 26801 to 26811)." (*Meyer.*)

27173. Olea europaea L. **Olive.**

From near Gagri, Caucasus, Russia. "(No. 1237a, January 31, 1910.) Collected from wild growing trees which occur quite plentifully on dry mountain slopes and on cliffs along the Caucasian shore of the Black Sea; they might have escaped from cultivation in the far past, as formerly this region was the center of a great civilization. These wild olive trees are very bushy and apparently very drought resistant and may be used in similar regions as recommended for Nos. 388 to 389 (S. P. I. Nos. 26801 to 26811)." (*Meyer.*)

27174. Nicotiana tabacum L. **Tobacco.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 1238a, February 12, 1910.) '*Trebizond.*' A very good variety of Turkish cigarette tobacco, producing medium-sized, long, oblong leaves, which assume a beautiful light-amber color when properly cured. This tobacco is grown in great quantities in this region and much exported. It is planted rather late in the season and needs a somewhat gravelly, warm soil to succeed well. Will probably be adapted to certain sections of northern Florida and southern Georgia." (*Meyer.*)

27175. Nicotiana tabacum L. **Tobacco.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 1239a, February 11, 1910.) '*Samsun.*' A good variety of Turkish cigarette tobacco, producing many rather small leaves (6 to 8 inches long) of pointed, oblong shape, which, when cured well, have a medium-dark chocolate-brown color. Grown and exported like the preceding variety in great quantities, although it is considered locally not to be as fine a product as the '*Trebizond.*' Likes a warm soil, rich in vegetable matter, and stands the sea air quite well, as some plantations are situated almost on the edge of the Black Sea." (*Meyer.*)

27176. Nicotiana tabacum L. **Tobacco.**

From Cherg, Caucasus, Russia. "(No. 1240a, February 7, 1910.) A form of Turkish cigarette tobacco, apparently between '*Trebizond*' and '*Samsun.*' Much planted on burned-over forest land, somewhat away from the seacoast. For other remarks see Nos. 1238a and 1239a (S. P. I. Nos. 27174 and 27175)." (*Meyer.*)

27172 to 27193—Continued.

27177. Crataegus sp.

From near Gagri, Caucasus, Russia. "(No. 1241a, January 31, 1910.) A hawthorn growing in stony cliffs and on dry places. Mostly seen as a small shrub; has small leaves and bears small, scarlet berries, which persist throughout the winter on the bushes. Of value as an ornamental shrub in the southern parts of the United States." (*Meyer.*)

27178. Crataegus sp.

From near Novai, Avon, Caucasus, Russia. "(No. 1242a, February 6, 1910.) A hawthorn, much resembling the preceding number, but of more robust habit, which may be accounted for by a different location. For further remarks see No. 1241a (S. P. I. No. 27177)." (*Meyer.*)

27179. Crataegus sp.

From River Zjiep, Caucasus, Russia. "(No. 1243a, February 4, 1910.) A hawthorn growing into a tall shrub or small tree, having black, juicy berries, which persist through the winter. Found growing on dry and stony places. Of value like the preceding numbers (S. P. I. Nos. 27177 and 27178)." (*Meyer.*)

27180. Rosa sp. **Rose.**

From near Gagri, Caucasus, Russia. "(No. 1244a, January 31, 1910.) A very strong-growing wild rose, bearing many large fruits; found in rather dry, rocky locations. Probably a good stock in semitropical regions and for greenhouse forcing." (*Meyer.*)

27181. Rosa sp. **Rose.**

From near Gagri, Caucasus, Russia. "(No. 1245a, January 31, 1910.) A rose found in dry, exposed cliffs; of very vigorous growth, having many small fruits. Probably a good stock like the preceding number (S. P. I. No. 27180)." (*Meyer.*)

27182. Rosa sp. **Rose.**

From near Gagri, Caucasus, Russia. "(No. 1246a, January 31, 1910.) A wild rose, perhaps *Rosa cinnamomea*, found growing on a stony slope along a road. Has very long branches, which are nearly spineless. Of value in breeding experiments and as a stock like the preceding numbers." (*Meyer.*)

27183. Coronilla varia L.

From Orianda, Crimea, Russia. "(No. 1247a, January 25, 1910.) A leguminous shrub, from 2 to 3 feet high, found growing on dry and stony places near the seaside. Perhaps of value as a fodder and also as an ornamental plant in semiarid, mild-wintered regions." (*Meyer.*)

27184. Sorbus domestica L. **Mountain ash.**

From Yalta, Crimea, Russia. "(No. 1248a, January 25, 1910.) A mountain ash with large, edible fruits. The fruits are sold in fruit shops in Yalta as a delicacy, they are eaten when somewhat decomposed, like medlars, and taste very good. Of value as a fruit tree in mild-wintered regions, where the summers are warm and dry." (*Meyer.*)

Distribution.—Southern Europe, extending from southern France through the Balkans to Asia Minor, and occurring also in northern Africa.

27185. Sorbus sp.

From Orianda, Crimea, Russia. "(No. 1249a, January 25, 1910.) A small tree or large shrub, growing in shady places on the slopes of hills, apparently rare. Of value, perhaps, as an ornamental shrub in mild-wintered regions." (*Meyer.*)

27172 to 27193—Continued.

27186. Punica granatum L. **Pomegranate.**

From near Gagri, Caucasus, Russia. "(No. 1250a, January 31, 1910.) A pomegranate occurring wild in stony cliffs near the seashore. Of no particular value, save as an interesting wild plant, as the fruits are rather small and sour." (*Meyer.*)

27187. Arbutus andrachne L.

From Nikita, Crimea, Russia. "(No. 1251a, January 24, 1910.) A very interesting, ornamental, native tree of the Crimea, being evergreen and bearing scarlet edible berries, which vary much in size. Grows in stony cliffs and at the very brinks of precipices, where its gnarled, barkless, white or reddish trunks often give one the impression of some prehistoric creature. Of value as an ornamental tree or tall shrub in mild-wintered regions, where dry and hot summers prevail." (*Meyer.*)

Distribution.—In the woods on the lower slopes of the mountains of Greece and the Crimea and eastward through Asia Minor to Syria; also in the islands of the Grecian archipelago and in Crete and Cyprus.

27188. Photinia villosa laevis (Thunb.) Dippel.

From near Berlin, Germany. "(No. 1252a, October 27, 1909.) A tall bush with dark-green, long-persistent foliage, covered in late summer and autumn with scarlet berries. Of ornamental value in gardens and parks. Collected from a specimen in the Späth nurseries near Berlin, Germany." (*Meyer.*)

Distribution.—The provinces of Chekiang, Kiangsi, and Hupeh in southeastern China, Port Chusan in Korea, and in Formosa and Japan.

27189. Bupleurum fruticosum L.

From Orianda, Crimea, Russia. "(No. 1253a, January 25, 1910.) Seeds of an umbelliferous evergreen shrub, found growing on shady places, often quite near the seashore. Appears to stand clipping quite well and is sparingly seen as a clipped hedge. Of value as a seaside shrub in mild-wintered regions, beneath trees and on shady places." (*Meyer.*)

Distribution.—Along the shores of the Mediterranean from Spain and Portugal to Syria and in northern Africa.

27190. Medicago rigidula (L.) Desr.

From near Nikita, Crimea, Russia. "(No. 1254a, January 24, 1910.) An annual alfalfa growing here and there on gravelly hill slopes. Of value as a spring forage plant in mild-wintered regions, where hot and dry summers prevail." (*Meyer.*)

27191. Asparagus sp.

From Orianda, Crimea, Russia. "(No. 1255a, January 25, 1910.) A wild herbaceous asparagus, of climbing habits, found between shrubs near the seaside. Perhaps ornamental. Probably the same as No. 1234a (S. P. I. No. 26883). See this number for further remarks." (*Meyer.*)

27192. Viola sp. **Violet.**

From near Gagri, Caucasus, Russia. "(No. 1256a, February 1, 1910.) The same as Nos. 411 and 412 (S. P. I. Nos. 26863 and 26864), under which numbers live plants were sent. See these numbers for remarks." (*Meyer.*)

27193. Ruscus hypoglossum L.

From near Gagri, Caucasus, Russia. "(No. 1257a, February 1, 1910.) The beautiful, large-leaved butcher's-broom found on shady, somewhat moist

27172 to 27193—Continued.

places in the forest and between shrubbery and rocks. Very ornamental with its large, glossy, dark-green leaves, especially when bearing its large, orange-scarlet berries. Of value as a cover plant on shady places in parks and gardens in the southern United States." (*Meyer.*)

Distribution.—Shady banks among the mountains of southern Europe, extending from Spain, Italy, and southern Germany southeastward to Macedonia.

27194 to 27198.

From Shanghai, China. Presented by Rev. J. M. W. Farnham. Received March 25, 1910.

Seeds of the following:

27194. CANNABIS SATIVA L. **Hemp.**

27195. DOLICHOS LABLAB L. **Bonavist bean.**

27196 to 27198. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

27196. Large yellow seeded.

27197. Large green seeded.

27198. Black seeded.

27199. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From Philadelphia, Pa. Procured from Mr. Wm. Henry Maule. Received March 25, 1910.

Panmure Early Wonder.

"This is a valuable early and productive variety, yields enormously of shelled peas, which are excellent for table use during the winter. It makes an ordinary vine, not so rank as some other varieties; the stems that support the pods stand erect, 6 to 10 inches above all the vines, having 3 to 6 pods to each stem, and some pods contain as many as 20 peas, making them very easy to gather by hand picking, producing an average yield of 40 bushels of shelled peas per acre. A good soil improver, and relished by all farm stock." (*Maule.*)

27200. AGROSTIS ALBA L. **Creeping bent-grass.**

From Darmstadt, Germany. Received through Mr. Conrad Appel, March, 1910.

South German. Said to be the true creeping bent-grass.

27201 to 27288.

Grown during the season of 1909 at the experimental substation at Dickinson, N. Dak., for Mr. Charles J. Brand,[1] under the supervision of Prof. L. R. Waldron, and transmitted through Mr. Charles H. Clark. Numbered March, 1910.

Seed of the following; notes by Mr. Charles J. Brand.

27201 to 27257. MEDICAGO SATIVA L. **Alfalfa.**

Seed of open-pollinated plants grown from seed sown in 1908.

27201. *Grimm.* Grown from P. L. H. No. 3235. Source of parent seed, Fargo, N. Dak. (1900–1904). Introduced from Baden, Germany (1858). Sixty plants yielded 3½ pounds of seed. Average per plant 23.7 grams; 560 seeds per gram.

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[1] See Bulletin 185, Bureau of Plant Industry.

27201 to 27288—Continued.

27201 to 27257—Continued.

27202. *Grimm.* Grown from S. P. I. No. 21938. Source of parent seed, Excelsior, Minn. (1894–1907). Introduced from Baden, Germany. Fifty-four plants yielded 2⅜ pounds of seed. Average per plant 20 grams; 527 seeds per gram.

27203. Acclimatized *Turkestan.* Grown from P. L. H. No. 3252. Source of parent seed, Highmore, S. Dak. (1899–1906). Introduced from Tashkend, Turkestan (1898). Fifty-eight plants yielded 1⅛ pounds of seed. Average per plant 8.8 grams; 649 seeds per gram.

27204. *Mongolian.* Grown from S. P. I. No. 21232. Source of parent seed, Mongolia (small seed, imported 1907). Sixty-eight plants yielded 2½ pounds of seed. Average per plant 16.8 grams; 476 seeds per gram.

27205. *Turkestan.* Grown from S. P. I. No. 21032. Source of parent seed, Turkestan (imported 1907). Forty-two plants yielded 1½ pounds of seed. Average per plant 16 grams; 589 seeds per gram.

27206. *South Dakota 167* (*Baltic*). Grown from P. L. H. No. 3251. Source of parent seed, Highmore, S. Dak. (1905–1906). Grown at Baltic, S. Dak., 1894–1904. Forty-five plants yielded 4¼ pounds of seed. Average per plant 42 grams; 506 seeds per gram.

27207. *Mongolian.* Grown from P. L. H. No. 2125. Source of parent seed, Mongolia (medium seed, imported 1907). Forty-four plants yielded 1⅛ pounds of seed. Average per plant 11 grams; 459 seeds per gram.

27208. *Canadian.* Grown from S. P. I. No. 13436. Source of parent seed, Canada (imported 1904). Forty-one plants yielded 1¼ pounds of seed. Average per plant 14 grams; 579 seeds per gram.

27209. Montana. Grown from S. P. I. No. 12747. Source of parent seed, Billings, Mont. (crop of 1904). Thirty-eight plants yielded 1 pound of seed. Average per plant 11.8 grams; 606 seeds per gram.

27210. *Mongolian.* Grown from P. L. H. No. 2124. Source of parent seed, Mongolia (large seed, imported 1907). Forty-two plants yielded 1¼ pounds of seed. Average per plant 13 grams; 470 seeds per gram.

27211. Commercial *Turkestan.* Grown from S. P. I. No. 20988. Source of parent seed, Turkestan (imported 1907). Thirty-four plants yielded 1 pound of seed. Average per plant 13 grams; 615 seeds per gram.

27212. *Canadian.* Grown from S. P. I. No. 21247. Source of parent seed, Canada (imported 1907). Twenty-six plants yielded three-fourths pound of seed. Average per plant 12.9 grams; 545 seeds per gram.

27213. *Turkestan.* Grown from S. P. I. No. 9453. Source of parent seed, Bokhara, Turkestan (imported 1903). Thirty plants yielded 1 pound of seed. Average per plant 15 grams; 582 seeds per gram.

27214. Commercial *Turkestan.* Grown from S. P. I. No. 18751. Source of parent seed, Turkestan (imported 1906). Twenty-seven plants yielded one-half pound of seed. Average per plant 8 grams; 627 seeds per gram.

27201 to 27288—Continued.

27201 to 27257—Continued.

27215. *French.* Grown from S. P. I. No. 21187. Source of parent seed, France (imported 1907). Twenty-seven plants yielded 1¾ pounds of seed. Average per plant 29 grams; 508 seeds per gram. (Commercial sand lucern.)

27216. *German.* Grown from S. P. I. No. 21217. Source of parent seed, Germany (imported 1907). Twenty-three plants yielded 1⅛ pounds of seed. Average per plant 22 grams; 537 seeds per gram. (Commercial sand lucern.)

27217. *Turkestan.* Grown from S. P. I. No. 19968. Source of parent seed, Samarkand, Turkestan (grown in Kansas). Seventeen plants yielded five-eighths pound of seed. Average per plant 16 grams; 611 seeds per gram.

27218. *Turkestan.* Grown from S. P. I. No. 9452. Source of parent seed, Karabulak, Turkestan (imported 1903). Twenty plants yielded three-fourths pound of seed. Average per plant 17 grams; 612 seeds per gram.

27219. Nebraska. Grown from S. P. I. No. 12820. Source of parent seed, Clearwater, Nebr. (crop of 1904). Twenty plants yielded 1⅛ pounds of seed. Average per plant 25 grams; 531 seeds per gram.

27220. Montana. Grown from S. P. I. No. 12816. Source of parent seed, Chinook, Mont. (crop of 1904). Nineteen plants yielded 1½ pounds of seed. Average per plant 35 grams; 565 seeds per gram.

27221. Nebraska, dry land. Grown from S. P. I. No. 21945. Source of parent seed, Sextorp, Nebr. (crop of 1907). Sixteen plants yielded three-fourths pound of seed. Average per plant 21 grams; 535 seeds per gram.

27222. *Alt-Deutsche Fränkische Luzerne.* Grown from P. L. H. No. 3321. Source of parent seed Baden, Germany (imported 1908). Eighteen plants yielded 1 pound of seed. Average per plant 25 grams; 495 seeds per gram.

27223. First quality commercial. Grown from S. P. I. No. 11275. Source of parent seed, purchased in Chicago, 1904. Fifteen plants yielded one-half pound of seed. Average per plant 15 grams; 545 seeds per gram.

27224. Russia. Grown from S. P. I. No. 13857. Source of parent seed, Simbirsk, Russia (imported 1905). Twelve plants yielded one-half pound of seed. Average per plant 18 grams; 502 seeds per gram.

27225. *Turkestan.* Grown from S. P. I. No. 14786. Source of parent seed, Tashkend, Turkestan (imported 1905). Thirteen plants yielded one-half pound of seed. Average per plant 17 grams; 576 seeds per gram.

27226. *Algerian.* Grown from S. P. I. No. 12803. Source of parent seed, Setif, Algeria (imported 1905). Fourteen plants yielded five-eighths pound of seed. Average per plant 20 grams; 538 seeds per gram.

27227. *Mexican.* Grown from S. P. I. No. 11652. Source of parent seed, Guanajuato, Mexico (imported 1904). Seven plants yielded three-sixteenths pound of seed. Average per plant 12 grams; 548 seeds per gram.

27201 to 27288—Continued.

27201 to 27257—Continued.

27228. Kansas. Grown from S. P. I. No. 12671. Source of parent seed, Lawrence, Kans. (crop of 1904). Ten plants yielded three-fourths pound of seed. Average per plant 37 grams; 505 seeds per gram.

27229. *German.* Grown from S. P. I. No. 22418. Source of parent seed, Germany (imported 1908). Eleven plants yielded three-fourths pound of seed. Average per plant 31 grams; 519 seeds per gram. (Commercial sand lucern.)

27230. Utah, irrigated. Grown from S. P. I. No. 21828. Source of parent seed, Deseret, Utah (crop of 1907). Eleven plants yielded three-fourths pound of seed. Average per plant 31 grams; 581 seeds per gram.

27231. Montana. Grown from S. P. I. No. 13237. Source of parent seed, Chinook, Mont. (crop of 1904). Twelve plants yielded 1⅛ pounds of seed. Average per plant 42 grams; 530 seeds per gram.

27232. Colorado. Grown from S. P. I. No. 12398. Source of parent seed, Fort Collins, Colo. (crop of 1904). Nine plants yielded three-eighths pound of seed. Average per plant 19 grams; 530 seeds per gram.

27233. Nebraska. Grown from S. P. I. No. 13259. Source of parent seed, Milburn, Nebr. (crop of 1904). Ten plants yielded one-half pound of seed. Average per plant 22 grams; 512 seeds per gram.

27234. Utah, dry land. Grown from P. L. H. No. 3255. Source of parent seed, Nephi, Utah (crop of 1907). Nine plants yielded one-half pound of seed. Average per plant 25 grams; 582 seeds per gram.

27235. *Turkestan.* Grown from S. P. I. No. 9359. Source of parent seed, Erivan, Russia (imported 1903). Seven plants yielded one-fourth pound of seed. Average per plant 16 grams; 511 seeds per gram.

27236. Mexican. Grown from S. P. I. No. 11651. Source of parent seed, Pueblo, Mexico (imported 1904). Seven plants yielded one-eighth pound of seed. Average per plant 8 grams; 530 seeds per gram.

27237. Utah, irrigated. Grown from S. P. I. No. 12784. Source of parent seed, Emery, Utah (crop of 1904). Nine plants yielded one-fourth pound of seed. Average per plant 12.4 grams; 560 seeds per gram.

27238. *German.* Grown from S. P. I. No. 21269. Source of parent seed, Germany (imported 1908). Eight plants yielded 1 pound of seed. Average per plant 56 grams; 537 seeds per gram. (Commercial sand lucern.)

27239. Utah, dry land. Grown from P. L. H. No. 3256. Source of parent seed, Nephi, Utah (crop of 1907). Eight plants yielded three-fourths pound of seed. Average per plant 42 grams; 508 seeds per gram.

27240. Ordinary American. Grown from P. L. H. No. 3346. Source of parent seed, Richardton, N. Dak. (crop of 1907). Six plants yielded one-fourth pound of seed. Average per plant 18 grams; 603 seeds per gram.

27201 to 27288—Continued.

27201 to 27257—Continued.

27241. *Turkestan.* Grown from S. P. I. No. 991. Source of parent seed, Tashkend, Turkestan (imported 1898). Six plants yielded one-half pound of seed. Average per plant 37 grams; 606 seeds per gram.

27242. *Turkestan.* Grown from S. P. I. No. 20437. Source of parent seed, Tashkend, Turkestan (grown in Utah 1900–1906). Seven plants yielded three-sixteenths pound of seed. Average per plant 12 grams; 524 seeds per gram.

27243. *Turkestan.* Grown from S. P. I. No. 9450. Source of parent seed, Askabad, Turkestan (imported 1903). Four plants yielded three-sixteenths pound of seed. Average per plant 21 grams; 632 seeds per gram.

27244. Utah, irrigated. Grown from S. P. I. No. 21829. Source of parent seed, Deseret, Utah (crop of 1907). Seven plants yielded one-fourth pound of seed. Average per plant 16 grams; 534 seeds per gram.

27245. *French.* Grown from S. P. I. No. 20896. Source of parent seed, France (imported 1907). Five plants yielded one-fourth pound of seed. Average per plant 22.4 grams; 540 seeds per gram. (Commercial sand lucern.)

27246. Utah, dry land. Grown from S. P. I. No. 21867. Source of parent seed, Nephi, Utah (crop of 1907). Five plants yielded one-fourth pound of seed. Average per plant 22.4 grams; 550 seeds per gram.

27247. Utah, dry land. Grown from S. P. I. No. 22559. Source of parent seed, Gunnison, Utah (crop of 1907). Four plants yielded one-fourth pound of seed. Average per plant 28 grams; 581 seeds per gram.

27248. Commercial *Turkestan.* Grown from S. P. I. No. 18425. Source of parent seed, Turkestan (imported 1906). Three plants yielded 14 grams of seed. Average per plant 5 grams; 524 seeds per gram.

27249. *Poitou.* Grown from S. P. I. No. 12695. Source of parent seed, France (imported 1905). Four plants yielded three-eighths pound of seed. Average per plant 42 grams; 504 seeds per gram.

27250. Utah, dry land. Grown from S. P. I. No. 12409. Source of parent seed, Diamond Fork, Utah (crop of 1904). Three plants yielded one-fourth pound of seed. Average per plant 37 grams; 489 seeds per gram.

27251. *Italian.* Grown from S. P. I. No. 22416. Source of parent seed, Piedmont, Italy (imported 1908). One plant survived the winter of 1908–9, but its exact yield was lost; 459 seeds per gram.

27252. *Turkestan.* Grown from S. P. I. No. 13999. Source of parent seed, Tashkend, Turkestan (grown in Utah, 1900–1904). One plant yielded 12 grams of seed.

27253. *Argentine.* Grown from S. P. I. No. 3508. Source of parent seed, Mendoza, Argentina (imported in 1899). One plant yielded no seed.

27254. *Provence.* Grown from S. P. I. No. 22417. Source of parent seed, Germany (imported 1908). One plant yielded 28 grams of seed; 501 seeds per gram.

27201 to 27288—Continued.

27201 to 27257—Continued.

27255. *Argentine.* Grown from S. P. I. No. 3507. Source of parent seed Buenos Aires, Argentina (imported in 1899). One plant yielded 10 grams of seed.

27256. Utah, irrigated. Grown from S. P. I. No. 22558. Source of parent seed, Gunnison, Utah (crop of 1907). Eight plants yielded three-fourths pound of seed. Average per plant 42 grams; 530 seeds per gram.

27257. *Argentine.* Grown from S. P. I. No. 12549. Source of parent seed, Buenos Aires, Argentina (imported in 1905). One plant yielded 56 grams of seed; 567 seeds per gram.

"In making comparison as to yield of seed careful notice must be taken of the number of plants from which the yield was obtained. A large number indicates a thicker stand in the rows, hence less opportunity for full development. Fair comparisons may be made in most cases between strains represented by approximately the same number of plants."

27258 and 27259. MEDICAGO SATIVA L. **Alfalfa.**

27258. Commercial sand lucern. Grown from potted plants of S. P. I. No. 25110, which were started in the greenhouse at Washington and sent to Dickinson, N. Dak. Original seed received from Zurich, Switzerland. Fifty-five plants yielded 2⅜ pounds of seed, an average yield per plant of 20 grams.

NOTE.—This number and Nos. 27261 and 27262 below were not grown from seed produced at Zurich, but from samples that were submitted by seedsmen of Darmstadt, Germany, to the seed-control station for test.

27259. Grown from P. L. H. No. 3411, which is inbred *Grimm* alfalfa produced in 1908 at Dickinson, N. Dak., by a selected plant from the same parent seed as P. L. H. No. 3235 (see No. 27201 above). Present sample grown in 1909. Sixteen plants yielded 1 pound of seed, an average yield per plant of 29 grams. Mr. Waldron reports that the winter of 1909–10 killed a much larger percentage of this inbred strain than the open-pollinated *Grimm* included in various experiments. Whether this killing was due to deterioration or whether the selected parent happened to be a nonhardy one can not be said, but it suggests an interesting experiment.

27260. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

Grown from P. L. H. No. 3386, which is true sand lucern produced by S. P. I. No. 20571, obtained by Prof. N. E. Hansen from Ultuna, Sweden. Forty-nine plants yielded 2½ pounds of seed, an average per plant of 23 grams.

27261 to 27266. MEDICAGO SATIVA L. **Alfalfa.**

27261. *Commercial sand lucern.* Grown at Dickinson, N. Dak., from S. P. I. No. 25111 (see No. 27258 above). Fifty-two plants yielded 1⅜ pounds of seed, an average per plant of 12 grams.

27262. *Commercial sand lucern.* Grown at Dickinson, N. Dak., from S. P. I. No. 25112 (see No. 27258). Fifty-five plants yielded 2½ pounds of seed, an average per plant of 21 grams.

27263. Seed from volunteer plants that have persisted for several years on the site of an old experimental plat that was possibly *Grimm.*

27201 to 27288—Continued.

27261 to 27266—Continued.

27264. Utah alfalfa seed from transplanted plants mixed with seed of the volunteer plants mentioned under No. 27263.

27265. Utah alfalfa seed produced by plants of S. P. I. No. 12784, which has been transplanted at definite distances in a study of the soil-moisture requirements of stands of different thickness.

27266. *Grimm* alfalfa grown in cultivated rows 3 feet apart (plat 16). From seed produced by Mr. Gustav Rasche of Westbrook, Cottonwood Co., Minn. The seed used on plat 16 was produced in the thirteenth year from seeding, from seed obtained by Mr. Rasche near Waconia, Carver Co., Minn. (see No. 27481). A $\frac{1}{10}$-acre plat yielded at the rate of $5\frac{6}{10}$ bushels per acre.

27267. MEDICAGO RUTHENICA (L.) Trautv.

Seed collected in the first or seeding year from a ¼-acre plat (in cultivated rows) of Hansen's introduction of this species, S. P. I. No. 24451, from Charonte, Siberia.

27268. MEDICAGO FALCATA L.

Seed collected in the first or seeding year from a ¼-acre plat (in cultivated rows) of Hansen's introduction No. 24452, from Ob, Tomsk Province, Siberia. Photographs of the plats which produced this and the preceding number may be found in the second annual report of the Dickinson substation for 1909.

27269 to 27287. MEDICAGO SATIVA L. **Alfalfa.**

Seed from individual plants that were inclosed in wire cages to prevent cross-fertilization and were hand pollinated from time to time while in blossom:

27269. *Mongolian.* An individual plant of P. L. H. No. 2125 (see No. 27207 above). One plant yielded 1¼ grams of seed.

NOTE.—Inasmuch as covering with wire cages reduces materially the yield of seed, plants that have been caged and hand pollinated must not be considered typical of what these plants would do under normal conditions.

27270. *Mongolian.* An individual plant of P. L. H. No. 2125 (see No. 27207). This plant yielded 8¾ grams of seed.

27271 to 27273. *Turkestan.* Individual plants of S. P. I. No. 9453 (see No. 27213). The first yielded 3¼ grams of seed; the second 9¾ grams; the third 11 grams.

27274. *Turkestan.* An individual plant of No. 13999 (see No. 27252). One plant produced 4¼ grams of seed.

27275 to 27277. Acclimatized *Turkestan.* Grown from P. L. H. No. 3252 South Dakota No. 240 (see No. 27203). The first plant yielded 2¾ grams of seed; the second plant 1 gram; the third plant 3½ grams.

27278. Grown from an individual plant of *Canadian* alfalfa, No. 13436, which yielded 3¾ grams of seed. (See No. 27208.)

27279. *Mexican.* Grown from an individual plant of No. 11652, which produced 35¾ grams of seed (See No. 27227.)

27280 and 27281. Minnesota *Grimm.* Grown from No. 21938 (see No. 27202). The first plant yielded 25¼ grams of seed; the second 25½ grams.

27201 to 27288—Continued.

27269 to 27287—Continued.

27282 to 27284. North Dakota *Grimm.* Grown from P. L. H. No. 3235, which is identical with S. P. I. No. 13358. The first plant yielded 9¾ grams of seed; the second 12¼ grams; the third 14 grams. (See No. 27201.)

27285. *Commercial sand lucern.* Grown from an individual plant of No. 21217, from Darmstadt, Germany, which yielded 18¼ grams of seed. (See No. 27216.)

27286. Origin of parent seed unknown. One plant yielded 4 grams of seed.

27287. Origin of parent seed unknown. One plant yielded 5½ grams of seed.

NOTE.—The two preceding numbers are believed to be transplanted plants of *Peruvian* alfalfa No. 9303, which survived an earlier experiment.

27288. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

Grown from cuttings of No. 20571 (see No. 27260). Nineteen plants yielded 1⅛ pounds of seed. Average per plant 21 grams.

27289 to 27296.

From Bremen, Germany. Presented by Dr. Geo. Bitter, director, Botanical Garden. Received March 4, 1910.

Seeds of the following:

27289. AGROPYRON SEMICOSTATUM Nees.

Distribution.—Slopes of the Himalayas at an elevation of 6,000 to 12,000 feet, between Kashmir and Sikkim, India, and extending to Afghanistan and Turkestan.

27290. ELEUSINE TRISTACHYA Lam.

Distribution.—In the vicinity of Montevideo, Uruguay, and in Argentina, South America; introduced in the Azores, and in Spain and Italy.

27291. MELILOTUS SUAVEOLENS Ledeb.

27292. MELILOTUS WOLGICA Poir.

Distribution.—The southern part of Russia in the valley of the Volga River and the vicinity of the Caspian Sea.

27293. PHLEUM JAPONICUM Franch. & Sav.

Distribution.—Along sandy shores in the vicinity of Yokosuka, Japan.

27294. TRIGONELLA CALLICERAS Fisch.

Distribution.—The provinces around the Caspian Sea and in the Caucasus Mountains, southeastern Russia.

27295. TRIGONELLA CRETICA Boiss.

See No. 27148 for distribution of this species.

27296. TRIGONELLA GLADIATA Stev.

Distribution.—The countries bordering on the Mediterranean from Spain and France through Dalmatia and Greece eastward to Asia Minor, and in northern Africa.

27297 and 27298. Colocasia sp. **Dasheen.**

From China. Presented by Mr. Geo. Campbell, Kia-ying chau, China. Received March 29, 1910.

Tubers of the following; notes by Mr. Campbell:

27297. "Chinese name *Pak ho*, meaning white water lily. This should be planted anywhere from the end of the first month of the Chinese calendar to the second month (February). Take each tuber and cut off about a third of the root end before planting (this third is the perquisite of the hogs). It will do well in either loam or clay soil if one only gives it plenty of human urine by way of manure. '(The Chinese attach the greatest value to urine as manure but always dilute it freely before applying.)'"
The sprouts of these are white.

27298. "Chinese name *Chong chu.* It is named, I suppose, after the great city of Changchow fu, west of Amoy. The directions for planting this are the same as for the above (S. P. I. No. 27297), save that the time of planting corresponds to about the last week in January and first week in February."
The tips of the sprouts of these are pink.

27299 and 27300. Citrullus vulgaris Schrad. **Watermelon.**

From Hockanum, Conn. Presented by Mr. N. H. Brewer. Received March, 1910.

Princess Marie. Seed grown from S. P. I. No. 22657:

27299. "Dark seeds from melons whose flesh was a gray white and not as sweet as the yellow (S. P. I. No. 27300)." (*Brewer.*)

27300. "White seeds from a yellow-fleshed melon which was very sweet." (*Brewer.*)

In size these were larger than described, "being oblong like an ice-cream melon." (*Brewer.*)

27301. Rosa gigantea Collett. **Rose.**

From Oporto, Portugal. Presented by Baron de Soutellinho, 115 Entre Quintas, who procured his original plants from the Royal Botanic Gardens, Kew, England. Received March 29, 1910.

"It is now twenty-five years since Dr. (now Sir George) Watt discovered this king of wild roses in Manipur (India), and nineteen years since the late Sir Henry Collett sent seeds of it to Kew.

"Here is an account of it by Mr. Hildebrand, who knew and grew the rose in Burma; indeed, I believe he helped Sir Henry Collett to get it home to England: '*Rosa gigantea* grows in profusion immediately opposite the window I am now writing at, and for 100 yards or more away. The boles of some of the plants are as thick as a man's thigh. It is a creeper, and does not flower until it gets over or beyond the tree it climbs. These specimens are on large evergreen trees, and their roots are in limestone and vegetable mold, through which run innumerable springs of pure water. The boles never get the sun, and they are always in the neighborhood of the water, which, no doubt, the roots find. The whole of a large group of trees on the southern and western side is covered up to 50 or 80 feet with the rose's shoots, and when in full bloom they look like a sheet of white, and the air all round is most deliciously scented. It is certainly a glorious sight. The ground all round is strewed with the seeds of the rose in July.'" (*Extract from The Garden, February 9, 1907, p. 67.*)

27302 to 27304.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, March 25, 1910.

27302. Amygdalus fenzliana (Fritsch) Korsh.

From Tiflis, Caucasus, Russia. "(No. 472, March 7, 1910.) A shrubby ornamental almond, flowering in early spring, with white flowers; growing in semiarid sections in eastern Caucasus. Suggested as a stock for almonds and other stone fruits in mild-wintered, semiarid sections, also of value, possibly, in breeding a bushy, drought-resistant strain of almonds for semiarid regions. Obtained from the Tiflis Botanical Garden." (*Meyer.*) (Plants.)

Distribution.—Arid mountain slopes of the transcaucasian provinces of Russia, at Phalernum in Greece, and on the islands of Crete and Sicily.

27303. Prunus microcarpa Meyer.

From Tiflis, Caucasus, Russia. "(No. 473, March 7, 1910.) A shrubby, small-fruited cherry, flowering early in spring. Coming from the semiarid sections of southeastern Caucasus. To be tested as an ornamental flowering shrub and perhaps also as a stock for stone fruits in the semiarid sections of the United States. Obtained from the Tiflis Botanical Garden." (*Meyer.*) (Plants.)

Distribution.—The slopes of the Beshbarmak Mountains near the Caspian Sea, and in the province of Astrabad, northwestern Persia.

27304. Colchicum speciosum Stev.

From Tiflis, Caucasus, Russia. "(No. 474, March 7, 1910.) A bulbous plant, flowering in autumn with large showy flowers of dark rose color. The strong foliage appears in spring, but dies off in midsummer and after some weeks of rest the flowers appear. It likes semishady places. Of value as an ornamental garden plant in the mild-wintered sections of the United States. Obtained from the Tiflis Botanical Garden." (*Meyer.*) (Bulbs.)

Distribution.—On the slopes of the Caucasus Mountains in southeastern Russia, and in northern Persia. Generally cultivated as an ornamental.

27305 to 27309.

From Paris, France. Presented by Mr. Maurice L. de Vilmorin, 13 Quai d'Orsay. Received March 25, 1910.

Plants of the following:

27305. Berberis sinensis Desf.

"(Vilm. No. 4456.)"

Distribution.—The Provinces of Chihli, Shingking, and Kansu in China; near Laoling, Korea; and in Japan.

27306. Berberis sp.

"(Vilm. No. 3927.)"

27307. Berberis sanguinea Franch.

See No. 25942 for previous introduction.

27308. Clematis delavayi Franch.

Distribution.—On mountain slopes in the Province of Yunnan in southern China.

27309. Rosa sericea Lindl.

Variety *fructu rubro.*

27310. AMYGDALUS DAVIDIANA (Carr.) Beiss., Sch. and Zab. **Wild peach.**

From Tientsin, China. Presented by Captain Tsao, through Mr. Yung Kwai, first secretary of the Chinese Embassy in Washington, D. C. Received March 30, 1910.

"Mr. Yung Kwai informs us that these seeds were collected by Captain Tsao from a wild tree in the neighborhood of his plantation at Tientsin, China. Captain Tsao informed Mr. Yung Kwai that this wild peach is the form upon which are grafted all the ordinary varieties of peaches around Tientsin." (*Fairchild.*)

See No. 22009 for other description.

27311. GARCINIA sp.

From Lawang, Java. Presented by Mr. M. Buysman. Received March 25, 1910.

27312 to 27320. RUBUS FRUTICOSUS L. **Blackberry.**

From Chile. Received through Mr. José D. Husbands, Limavida, via Molina, Chile. Received March 26, 1910.

Seeds of the following:

27312 to **27315.** "Round varieties of wild blackberries. These show slight differences; all are good fruits and are extremely productive. The plants are of the excessive-growth class." (*Husbands.*)

27316 to **27320.** "Wild blackberries from near the seacoast, grown dry in the driest part of central Chile, still sufficiently near the sea to receive some benefit from the heavy marine dews. The plant growth is small, conical in form. The fruits are large (for wild fruits), fleshy, round sorts of extremely fine flavors and extra sweet. These are equally productive to any and some are even greater yielders." (*Husbands.*)

27321 to 27332. ORYZA SATIVA L. **Rice.**

From Philippine Islands. Received through Mr. Wm. S. Lyon, Manila. Received March 24 and 25, 1910.

Seeds of the following; native names as given by Mr. Lyon:

27321. *Kiabo.* Glutinous, remarkably fragrant.

27322. *Malakit-dure.* Black rice, but most prolific known, always estimated 100 to 1 and up.

27323. *Tuguis.*

27324. *Macan-pulat.* Late variety.

27325. *Quinalibo-Quinamalig.*

27326. *Guering-guering,* or properly *Kering-kering.*

27327. *Eputebem.*

27328. *Mimis.*

27329. *Calibo;* not *Calebo.*

27330. *Milagrosa.*

27331. *Macan.* Very early variety.

27332. *Macan Mimi.* Specifically meaning exceptionally white.

27333 and 27334. Oryza sativa L. **Rice.**

From Cairo, Egypt. Presented by Mr. George P. Foaden, secretary, Khedivial Agricultural Society. Received March 31, 1910.

Seeds of the following:

27333. *Sultani*, known as *Ein el Bint.*

27334. *Sabeini.*

27335 to 27343.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, March 31, 1910.

Seeds of the following:

27335. Gleditsia caspica Desf.

From Tiflis, Caucasus, Russia. "(No. 1264a, March 7, 1910.) A honey locust growing into a rather spreading, densely branched, low tree, bearing a multitude of heavy, fleshy pods. Of value as a shade and park tree in the semiarid regions of the United States. Obtained from the Tiflis Botanical Garden." (*Meyer.*)

27336. Amygdalus fenzliana (Fritsch) Korsh.

From Tiflis, Caucasus, Russia. "(No. 12653, March 7, 1910.) For detailed description see No. 472 (S. P. I. No. 27302). Obtained from the Tiflis Botanical Garden." (*Meyer.*)

27337. Prunus microcarpa Meyer.

From Tiflis, Caucasus, Russia. "(No. 1266a, March 7, 1910.) For detailed description see No. 473 (S. P. I. No. 27303). Obtained from the Tiflis Botanical Garden." (*Meyer.*)

27338. Colchicum speciosum Stev.

From Tiflis, Caucasus, Russia. "(No. 1267a, March 7, 1910.) For detailed description see No. 474 (S. P. I. No. 27304). Obtained from the Tiflis Botanical Garden." (*Meyer.*)

27339. Crataegus sp.

From Sukhum-Kale, Caucasus, Russia. "(No. 1268a, February 14, 1910.) An evergreen ornamental hawthorn, probably a form of *C. pyracantha.* Of strong-growing habits, but somewhat irregular growth. Of value as an ornamental evergreen in the mild-wintered sections of the United States. Obtained from the Botanical Garden at Sukhum." (*Meyer.*)

27340. Citrullus vulgaris Schrad. **Watermelon.**

From near Kopetnari, Caucasus, Russia. "(No. 1269a, March 1, 1910.) A native Mingrelian variety of watermelon, having red flesh and said to be very sweet. To be tested in California or the southern Rocky Mountain region, where the climate approaches that of this section of the Caucasus." (*Meyer.*)

27341. Cucumis melo L. **Muskmelon.**

From near Kopetnari, Caucasus, Russia. "(No. 1270a, March 1, 1910.) A native Mingrelian variety of muskmelon of small size, but said to be very sweet. To be tried in similar regions as the preceding numbers." (*Meyer.*)

27342. Inodes sp.

From Sukhum-Kale, Caucasus, Russia. "(No. 1271a, February 11, 1910.) A low-growing palm, suitable for planting along driveways, paths in orchards, or in places where tall palms are not wanted. This palm does not form a real trunk, but has its leaves come from a rosette. Obtained from Mr. Smitskoi's place near Sukhum, where the climate is mild enough to grow oranges and other citrus fruits." (*Meyer.*)

27335 to 27343—Continued.

27343. MEDICAGO HISPIDA DENTICULATA (Willd.) Urban. **Bur clover.**

From Sukhum-Kale, Caucasus, Russia. "(No. 1272a, February 12, 1910.) An annual bur clover, found growing along an embankment. For remarks as to probable uses see No. 1201a (S. P. I. No. 26673)." (*Meyer.*)

NOTE.—For other species picked out of this lot see No. 27675.

27344 to 27360.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, March 31, 1910.

Cuttings, unless otherwise noted, were received of the following:

27344. CORYLUS MAXIMA Miller. **Filbert.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 430, February 10, 1910.) A filbert bearing the name *Badem fondook*, a native of the Caucasus. Much grown for its fine, oblong nuts, which find a ready sale. Obtained from the experimental station near Sukhum. Suitable for the Gulf region and the southeastern sections of the United States." (*Meyer.*) (Plants and cuttings.)

Distribution.—Southern Europe, extending from the Istrian peninsula of Austria eastward to Macedonia.

27345. CORYLUS AVELLANA L. **Hazelnut.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 431, February 10, 1910.) A hazelnut bearing the name *Zaksky fondook*, a native of the Caucasus. Nuts medium sized. See No. 430 (S. P. I. No. 27344) for source and regions to which it will be best adapted." (*Meyer.*) (Plants and cuttings.)

27346. CORYLUS AVELLANA L. **Hazelnut.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 432, February 10, 1910.) A hazelnut bearing the name *Trapezond fondook*, a native of the Caucasus. Nuts very large and generally well filled. The most widely grown variety here in the Caucasus. See No. 430 (S. P. I. No. 27344) for source and regions to which it will be best adapted." (*Meyer.*)

27347. CORYLUS AVELLANA L. **Hazelnut.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 433, February 10, 1910.) A hazelnut bearing the name *Kerasund fondook*, a native of the Caucasus. Nuts medium sized. See No. 430 (S. P. I. No. 27344) for source and regions to which it will be best adapted." (*Meyer.*) (Plants and cuttings.)

27348. CORYLUS AVELLANA L. **Hazelnut.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 434, February 10, 1910.) A native hazelnut of the Caucasus, called *Basset*. It bears medium-sized nuts. See No. 430 (S. P. I. No. 27344) for source and regions to which it will be best adapted." (*Meyer.*)

27349. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 441, February 15, 1910.) *Aturk ash* (translated Turkish grape). This produces medium-sized clusters of white grapes which ripen late in the season and are suitable for table use as well as for wine. A strong grower; has to be pruned with long wood, like all Caucasian grapes, to insure good harvests. Obtained from the vineyard of Mr. Smitskoi, near Sukhum." (*Meyer.*)

27350. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 442, February 15, 1910.) *Ash Khuta.* This produces a medium-sized bunch of whitish-colored berries,

27344 to 27360—Continued.

which are rosy when fully ripe, and have soft, juicy flesh; they are not very good as a table grape, but fine for wine production. A strong grower; has to be pruned with long wood to insure good crops. Obtained from the same source as the preceding number (S. P. I. No. 27349)." (*Meyer.*)

27351. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 443, February 15, 1910.) *Agra Ash.* A grape of dark-red color which produces a very dark-red wine. Not fit for table use, only a wine producer. Of medium-strong growth; has to be pruned with long wood to insure good crops. Obtained from the same source as No. 441 (S. P. I. No. 27349)." (*Meyer.*)

27352. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 444, February 15, 1910.) *Achgau.* A grape of dark-purple color, ripening late. Good for wine production. Very long internodes. Has to be pruned with long wood to insure good crops. Obtained from the same source as No. 441 (S. P. I. No. 27349)." (*Meyer.*)

27353. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 445, February 15, 1910.) *Achkiek.* A grape of bluish-red color, long, oblong berries, late ripener, and a fine table variety. A strong grower, making very long twigs; to be pruned with long wood to insure good crops. Obtained from the same source as No. 441 (S. P. I. No. 27349)." (*Meyer.*)

27354. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 446, February 15, 1910.) *Kachich.* A grape of blue-black color, late in ripening, only fit for wine making. A strong grower, making long twigs; should be pruned long to insure good crops. Obtained from the same source as No. 441 (S. P. I. No. 27349)." (*Meyer.*)

27355. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 447, February 15, 1910.) *Amlachu.* A grape of light-red color, late in ripening. Produces a rather good wine, not a table variety. Of medium-strong growth. As to pruning and locality where obtained see No. 441 (S. P. I. No. 27349)." (*Meyer.*)

27356. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 448, February 15, 1910.) *Awasarghua.* A fine table grape of Caucasian origin, medium-sized bunches, rather small berries, white in color, hard fleshed, of sweet taste. A very late ripener (end of November, beginning of December). A medium-strong grower; should be pruned with long wood to insure good crops. Obtained from the same source as No. 441 (S. P. I. No. 27349). This grape also produces a good wine." (*Meyer.*)

27357. VITIS VINIFERA L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 449, February 15, 1910.) A native Caucasian grape, coming originally from Derbent (Caucasus). Producing heavy bunches of round berries, large size and of white color; taste, not very sweet, but offset by extraordinarily long-keeping qualities. Considered a fine table grape, especially good for shipping. A strong grower; has to be pruned with long wood to insure good crops. Native name of this grape *Agadai.* From the same locality as No. 441 (S. P. I. No. 27349)." (*Meyer.*)

27344 to 27360—Continued.

27358. Vitis vinifera L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 450, February 15, 1910.) *Schachisum.* A native Caucasian grape, coming originally from Derbent. Considered a fine table grape; berries long, finger-shaped, with hard flesh; color whitish, but rose when fully ripe; very late in ripening, not very sweet, but having excellent keeping qualities, a good grape for shipping. To be pruned with long wood to insure good crops. Obtained from the same source as No. 441 (S. P. I. No. 27349)." (*Meyer.*)

27359. Vitis vinifera L. **Grape.**

From near Sukhum-Kale, Caucasus, Russia. "(No. 451, February 15, 1910.) *Achisum.* A Turkish table grape, having round berries of a white color, somewhat striped, sweet taste, hard flesh, and good keeping and shipping qualities. Obtained from the same source as No. 441 (S. P. I. No. 27349)." (*Meyer.*)

27360. Laurocerasus officinalis Roem. **Laurel cherry.**

From Dioscuria, near Sukhum-Kale, Caucasus, Russia. "(No. 453, February 16, 1910.) A very handsome variety of the laurel cherry, having very dense, glossy foliage. Comes from the high mountains of the Caucasus, and is able to stand 20° Reaumur below zero (−13° F.) For this reason it is suitable for regions where heretofore we have been unable to grow this handsome evergreen. Obtained through Mr. E. H. Albrecht, head gardener of the estates Sings and Dioscuria, near Sukhum." (*Meyer.*)

Distribution.—In the woods on the lower slopes of the mountains in Greece, in the transcaucasian provinces of Russia, and in the northern part of Persia.

27361. Dysoxylum sp.

From Buitenzorg, Java. Procured by Mr. A. J. Perkins. Received March 11, 1910.

Seed of a forest tree.

27362 and 27363. Vitis vinifera L. **Grape.**

From Almeria, Spain. Procured by Mr. Edward J. Norton, American consul, Malaga, Spain. Received March 31, 1910.

Cuttings of the following:

27362. *Ohanez.* Procured for growing in California in order to determine definitely whether what is now grown quite extensively there as the *Ohanez* is in reality this variety.

27363. *Castiza* or black grape and *Castiza especial.*

Note.—The letter received from the consul on April 11, 1910, discloses the fact that there were two varieties in this lot; as there was no way of distinguishing this at the time, they were given the one number and distributed; it will be impossible to distinguish them now until the vines fruit, at which time they will be separated and given different numbers.

"*Ohanez* grape, synonym *Casta de Ohanez* or *Uva de Lonja.* Though several different grapes are met with near Almeria, this is by far the most important one, and the extraordinary carrying and keeping qualities of its fruit has led to the establishment of the shipping industry for which Almerias are now so well known. Some confusion seems to exist as to this variety, various varieties being sometimes called Almeria which have nothing in common with the true Ohanez. It will need to be grown in the warmer localities of the Vinifera regions as it is a very late grape and would not ripen in the cooler sections. As the fertile buds

27362 and 27363—Continued.

are located some distance from the base of the canes it will require long pruning. Usually the vines are pruned to several long canes, with occasional spurs to enable keeping the shape of the vine. The variety is only partly self-fertile and artificial fertilization is therefore necessary. A wild staminate Vinifera known as *Flor* has been largely grown with it to supply the deficiency of pollen. Another table variety known as *Castiza* having red grapes is also used as a pollenizer. Bees are scarce in the Almerian parras owing to the absence of flowering plants. No doubt bees would greatly assist in the pollenization." (*Geo. C. Husmann.*)

27364 to 27399.

From Dickinson, N. Dak. Grown under the supervision of Mr. Charles J. Brand in collaboration with Prof. L. R. Waldron at Dickinson during the season of 1909. Seed from cuttings and seed from various sources grown in pots in the Department greenhouse at Washington and sent to the experimental substation at Dickinson.

Seed of the following; notes by Mr. Charles J. Brand:

27364. MEDICAGO SATIVA L. **Alfalfa.**

Seed from cuttings of a woody, semiupright plant with dusky-purple flowers and small, obovate leaves. Dickinson seed produced from cuttings of a plant grown at Lanham, Md., from seed received under this name from the Botanical Gardens, Madrid, Spain. Two plants yielded 3 ounces of seed.

27365. MEDICAGO SATIVA L. **Alfalfa.**

Dickinson seed from cuttings of a plant grown at Lanham, Md., from seed secured from the Botanical Gardens, Madrid, Spain. The parent plant had small, loose pods coiled from one to two turns, few flowers in the head, and those of lavender color. Six plants yielded 4 ounces of seed.

27366. MEDICAGO SATIVA VARIA (Mart.) Urban. **Sand lucern.**

Grown from seed taken from a coiled pod having three turns, found on a plant of No. 20571, normally bearing sickle-shaped pods and variegated flowers. Progeny from seed of sickle-shaped pods of this same plant is represented by No. 27370, below. Four plants yielded 3 ounces of seed.

27367. MEDICAGO SATIVA L. **Alfalfa.**

Produced at Dickinson from seed of a plant grown at Lanham, Md., from seed secured from the Botanical Gardens of Madrid, Spain. Four plants yielded 7 ounces of seed.

27368 and **27369.** MEDICAGO SATIVA L. **Alfalfa.**

27368. *Mielga.* Grown from a plant of wild alfalfa secured by Mr. M. Fraile, of the Bureau of Plant Industry, near Salamanca, Spain. This plant was grown in the department greenhouse at Washington and sent by mail to Dickinson. One plant yielded 1 ounce of seed. (The name "Mielga" is never applied to cultivated alfalfa).

27369. Grown at Dickinson from cuttings obtained at Lanham, Md. Original seed from Botanical Gardens, Madrid, Spain.

27370. MEDICAGO SATIVA VARIA (Mart.) Urban. **Sand lucern.**

Grown from seed of a sickle-shaped pod taken from an individual plant of No. 20571, which came from Ultuna, Sweden. The mother plant normally bore sickle-shaped pods. The progeny of a coiled pod of the same plant is listed under No. 27366. The mother plant had variegated flowers showing the smoky yellow-violet combination of colors typical of true sand lucern.

27364 to 27399—Continued.

27371. Medicago sativa L. **Alfalfa.**

Propagated from a few seed of wild alfalfa collected by Mr. M. Fraile, of the Bureau of Plant Industry, near Villamayor, Spain.

27372. Medicago sativa L. **Alfalfa.**

Grown from cuttings secured at Lanham, Md. Original seed from Botanical Gardens, Madrid, Spain. Six plants yielded 7 ounces of seed.

27373 and 27374. Medicago sativa varia (Mart.) Urban. **Sand lucern.**

27373. Produced from cuttings of a plant of No. 20571. The parent plant bore typically variegated flower heads, has small leaves, loosely coiled pods, with one-half to one and one-half turns, and very woody stems. Six plants yielded 3 ounces of seed.

27374. Seed from cuttings of a plant of No. 20571, which bore faded bluish-colored flowers with violet veins. Three plants yielded 4 ounces of seed.

27375. Medicago falcata L. **Sickle lucern.**

Seed from cuttings of No. 20717, collected by Prof. N. E. Hansen near Kharkof, Russia. The parent plant was low spreading and vigorous. Five plants grown from cuttings yielded 4 ounces of seed. The plants that produced the present seed were grown in close proximity to *M. sativa*, hence a *sativa* × *falcata* cross may have resulted.

27376 to 27378. Medicago sativa L. **Alfalfa.**

27376. Seed produced from cuttings of a plant grown at Lanham, Md., from seed presented by the Botanical Gardens, Madrid, Spain. The parent plant was exceedingly vigorous and rapid of growth, upright in habit and produced unusually large leaves. Five plants yielded 5 ounces of seed.

27377. *Mielga.* Progeny of a wild alfalfa plant collected by Mr. M. Fraile, of the Bureau of Plant Industry, near Villares de la Reina, Spain. (See No. 23391.) Five plants yielded 3 ounces of seed.

27378. Seed grown from cuttings of two selected individuals that yielded 1 ounce of seed.

27379. Medicago sativa L. **Alfalfa.**

Grown at Dickinson from cuttings of a plant produced at Lanham, Md. Original seed from Botanical Gardens, Madrid, Spain. Pods of good size, loosely coiled from one to three times; leaves small, flowers dusky purple. Three plants yielded 4 ounces of seed.

27380. Medicago sativa L. **Alfalfa.**

Grown from S. P. I. No. 22949, which represents seed of the wild alfalfa plant collected by Mr. José D. Husbands near Limavida, Chile. Four plants yielded 4 ounces of seed.

27381. Medicago sativa L. **Alfalfa.**

Grown from seed produced at Lanham, Md. Original seed from Botanical Gardens, Madrid, Spain. Parent plant was vigorous and woody, has small leaves and white flowers. It was grown in association with other species and varieties so that crossing may have occurred readily. Two plants yielded 4 ounces of seed at Dickinson.

27364 to 27399—Continued.

27382 to 27399.

Seed from selected plants that were open pollinated:

27382 to 27384. Medicago sativa varia (Mart.) Urban. **Sand lucern.**

27382 and 27383. Grown from cuttings of S. P. I. No. 20571 (see No. 27260, above). The first plant yielded 37¾ grams of seed; the second 25¾ grams.

27384. Grown from P. L. H. No. 3386, which represents seed of No. 20571. As both 3386 and the present lot were produced in association with ordinary alfalfa, unlimited opportunity for crossing existed. One plant yielded 36 grams of seed.

27385 to 27391. Medicago sativa L. **Alfalfa.**

27385 and 27386. Grown from two plants of S. P. I. No. 25112 (see No. 27262, above). The first plant yielded 29 grams; the second 27 grams of seed.

27387. Grown from an individual plant of S. P. I. No. 25111 (see No. 27261). One plant yielded 42 grams of seed.

27388 to 27391. Grown from four selected plants of S. P. I. No. 25110 (see No. 27258). The first plant yielded 2 grams of seed; the second 44½ grams; the third 19½; the fourth 7 grams; showing admirably the great diversity in value as to seed production of the individuals composing the stand of alfalfa.

27392 and 27393.

Note.—When the material to which these numbers were assigned was thrashed, no seed was found, so they were not used.

27394. Medicago falcata L. **Sickle lucern.**

Grown at Dickinson from cuttings of Hansen's introduction of this species No. 20721, from Samara, Russia. One plant yielded one-fourth gram of seed. As this was grown in association with true alfalfa the present number may represent the immediate hybrid between *sativa* and *falcata*—*Medicago sativa varia* (Mart.) Urban, or true sand lucern.

27395 to 27397. Medicago sativa L. **Alfalfa.**

27395. Grown from a cutting which yielded 10 grams of seed.

27396. Grown from a cutting which yielded 17 grams of seed.

27397. Grown from seed of this species produced at Lanham, Md. Original seed from Madrid, Spain. Parent plant had loose, open pods, many of them broadly falcate. At Dickinson one plant yielded 36¼ grams of seed.

27398. Medicago sativa varia (Mart.) Urban. **Sand lucern.**

Grown from cuttings of S. P. I. No. 20571 (see No. 27260). One plant yielded 46½ grams of seed.

27399. Medicago sativa L. **Alfalfa.**

Grown from seed produced at Lanham, Md. Original seed from Madrid, Spain. One plant yielded 9 grams of seed.

27400 to 27417.

From Paris, France. Presented by Mr. Maurice L. de Vilmorin. Received March 21, 1910.

Seeds of the following:

27400 and 27401. BERBERIS DICTYOPHYLLA Franch.

27400. Variety *albicaulis.*

27401. Variety *petiole rose.* (Vilm. No. 4.113.)

27402. BERBERIS HENRYANA Schneider (?).

Distribution.—Discovered in the Province of Hupeh, central China.

27403 and 27404. BERBERIS TIBETICA Hort. (?)

27403. (Vilm. No. 3.939.)

27404. (Vilm. No. 4.681.)

27405. BERBERIS YUNNANENSIS Franch.

Distribution.—On the mountains at an altitude of about 10,000 feet in the Province of Yunnan, southern China.

27406. BERBERIS sp.
(Vilm. No. 3.448.)

27407. COTONEASTER ADPRESSA Bois.

Distribution.—This species is reported from China without any definite locality. It was grown in the Vilmorin nurseries near Paris.

27408. CORYLUS FEROX TIBETICA (Bat.) Franch.

Distribution.—Along the banks of Tshagon River in the Province of Kansu, and in the Provinces of Hupeh, Shensi, and Szechwan, China.

27409. JUGLANS MANDSHURICA Maxim.

Distribution.—Among the mountains in the Provinces of Chihli, Hupeh, Szechwan, and Yunnan, in China, and in Manchuria and Amur, eastern Siberia.

27410. LONICERA SYRINGANTHA Maxim.

Distribution.—Known only from the Province of Kansu in northwestern China.

27411. PRUNUS CANESCENS Bois.

Distribution.—Known only from the Province of Szechwan in central China.

27412. PRUNUS MANDSHURICA (Maxim.) Koehne.

Distribution.—Southern Manchuria in the vicinity of Lake Khanka and along Sungari River.

27413. PRUNUS sp.
(Vilm. No. 1037.)

27414. ROSA SERICEA Lindl.

Variety *fructo luteo.*

27415. VITIS PAGNUCCII Rom.

Distribution.—The Provinces of Shensi and Hupeh in central China.

27416. VITIS TITANEA Ndn. (?)

27417. ZANTHOXYLUM CHENSI Hort. (?)

27418 to 27462.

From Chile. Received through Mr. José D. Husbands, Limavida, via Molina, Chile, March 18, 1910.

Seeds of the following. Descriptive notes by Mr. Husbands:

27418. ACACIA CAVENIA (Mol.) Bert.

See No. 24309 for description.

27419. BERBERIS CHILENSIS Gill.

"*Michay.* A yellow-flowered, thorned, dark-leaved, evergreen bush about 6 feet high, suitable for live fences and ornament. The Indians eat the fruit."

27420. CAESALPINIA BREVIFOLIA (Clos) Baill.

"*Algarrobillo.* A wild bush from the dry rainless north, near Huasco. This is a valuable industrial plant, grown for its tannin, of which it has 40 per cent. It is also a beautiful flowering ornamental."

27421. CEREUS QUISCO Gay.

"*Guillaves.* A cactus which grows very tall and perfectly straight, with an extra-large, double, fragrant white flower and comestible fruit."

27422. CUCURBITA sp. **Squash.**

"A field variety."

27423 to 27429. FRAGARIA CHILOENSIS (L.) Duchesne. **Strawberry.**

27423. "Light red, pink flesh, fine flavor, medium to large size, early."

27424. "Flesh pink outside and white inside, very sweet and fine flavored, short stems, prolific.

27425. "Fresh pink outside and white inside, very sweet and fine flavored, softens quickly, long stems, prolific."

27426. "Outside yellow; flesh white, extra firm; good keeper; lacks flavor and sweetness; extra large; prolific; short stems."

27427. "Light red or crimson tops with the bottom tip white; flesh pink near the outside, white center, good flavor."

27428. "White and pink, firm flesh, not much flavor; good shippers."

27429. "White inside and outside; extra-firm flesh; good shipper; less flavor than red varieties."

"The medium-sized red varieties are softer fleshed, sweeter, and better flavored than the white kinds; they do not keep long when picked, and must be used fresh. The large white and yellow classes have solid flesh, are good keepers and shippers. While they lack the exquisite flavor of American varieties, they are good eating and are highly esteemed as desirable sorts. The demand is largely in excess of the supply."

27430 and 27431. HELIANTHUS ANNUUS L. **Sunflower.**

27430. "This variety flowers at every leaf, and afterwards flowers again."

27431. "This variety has 27 flowers on 1 stalk."

27432. LAURELIA SEMPERVIRENS (Ruiz and Pav.) Tul. **Laurel.**

"From the island of Maucera, near Corral, the port of Valdivia."

27433 and 27434. LITHREA CAUSTICA (Mol.) Hook. and Arn.

27433. "From the dry inland coast country."

27434. From the Cordilleras.

27418 to 27462—Continued.

27435. LOLIUM MULTIFLORUM Lam. **Italian rye-grass.**

"Probably Chile's best all-round wild pasture grass. May be classed as equal to timothy. Annual."

27436. MAYTENUS MAGELLANICUS (Lam.) Hook. f.

"*Maiten.*"

27437. MEDICAGO LUPULINA L.

"*Gualputa.* · A new sort from the highlands of the Cordilleras."

27438. MEDICAGO SATIVA L. **Alfalfa.**

"Seed from a wild alfalfa plant found in the virgin forest of the inner Cordilleras at a high altitude."

27439. MELILOTUS INDICA (L.) All.

"A wild sweet clover, yellow flowered, highly esteemed for fodder; eaten by all animals."

27440. NOTHOFAGUS sp. **"White oak."**

"A fine timber tree for any industrial use."

27441 to 27450. RUBUS FRUTICOSUS L. **Blackberry.**

"The fruits of these are round, uniform size, from five-eighths to three-fourths of an inch in diameter; they are all sweet and good flavored, some especially so. All of them may be considered as early sorts. The later kinds are the same, except as to their fruiting time. The fruits are good and not overseeded, and have an abundance of sweet, agreeably flavored flesh and juice. In their wild state they would serve well for commercial and domestic uses if the people had learned to esteem them. The only objection is their excessive plant growth, for they are extra productive. The plant growth of all the strains is about equal; 15 feet would be an average height; they spread quickly, birds eat the fruit and sow the seeds, or if a tiny bit of root be left in the ground they soon thrive again under any conditions. They make an effective hedge or impassable barricade, but need annual pruning to keep them in their required place, or they will spread, fill irrigating canals, usurp adjoining land, and become a pest. The southern classes have less plant growth, different-shaped fruit, and smaller bunches, with flavors of their own. I consider the blackberries of the south as superior to those of central Chile (Nos. 27442, 27443, and 27446), but incomparably less productive. If by crossing you can obtain their flavors and great productiveness upon dwarf plants, you have made a progressive advance."

27451. SPARTIUM JUNCEUM L.

"*Retama.* A beautiful leafless bush or treelet, 6 to 8 feet high, with large, yellow, delightfully fragrant flowers, which remain in bloom a long time."

27452 and 27453. SOLANUM sp. **Potato.**

27452. "From the far South." **27453.** (No note.)

27454. SOPHORA MACROCARPA Smith.

"A beautiful tree, whose fruit is comestible."

27455. STRYCHNOS sp.

"A beautiful dwarf ornamental tree, from the innermost Cordilleras near the perpetual-snow line."

27456. TRACHYCARPUS EXCELSUS (Thumb.) Wendl.

"A dwarf palm, trunk covered with hair. For lawn decoration or garden."

27418 to 27462—Continued.

27457. Trifolium pratense L. **Red clover.**

27458. Triticum durum Desf. **Wheat.**

"A sample of black-bearded wheat found growing among other sorts."

27459. (Undetermined.)

"*Guilli-Patagua* or *Naranjillo*. A splendid evergreen tree. When in flower the entire wood and branches are covered with blooms, which give the tree the appearance of being trimmed with yellow lace."

27460. (Undetermined.)

27461. (Undetermined.)

"A flowering forest tree that has yellow flowers."

27462. (Undetermined.)

"*Alberjillas.*" Same remarks apply to this as to No 27455.

27463 to 27477. Melilotus spp.

From Madrid, Spain. Presented by the Madrid Botanical Garden. Received March 25, 1910.

Seeds of the following:

27463. Melilotus alba Desr.

27464 and 27465. Melilotus dentata (Waldst. & Kit.) Pers.

Distribution.—Europe and western Asia, extending from Sweden and the British islands eastward through Russia, Servia, Roumania, and Asia Minor to Siberia and Turkestan.

27466 to 27468. Melilotus indica (L.) All.

27469. Melilotus indica tommasinii (Jord.) Schultz.

Distribution.—The Sinai peninsula, Arabia.

27470. Melilotus italica (L.) Lam.

Distribution.—Along the northern shore of the Mediterranean from southern France eastward through Italy, Corsica, Sardinia, Sicily, and Greece to Asia Minor.

27471. Melilotus messanensis (L.) All.

See No. 25213 for distribution of this species.

27472. Melilotus speciosa Durieu.

Distribution.—Cool rocky slopes of the hills in the vicinity of Oran and La Calle, in Algeria, and also on the island of Mauritius.

27473. Melilotus segetalis (Brot.) Ser.

Distribution.—The countries bordering on the Mediterranean from Spain and southern France, through Italy, Greece, and Asia Minor to Syria, and in North Africa.

27474. Melilotus suaveolens Ledeb.

Distribution.—Eastern Asia, extending from Siberia, Turkestan, and India eastward to Korea, China, and Japan.

27475 to 27477. Melilotus taurica (Bieb.) Ser.

Distribution.—Sterile mountain slopes in the Crimea, and in Asia Minor and Kurdistan.

27478 and 27479.

From Japan. Presented by the Japan Nursery Company (Ltd.), Settsu, Japan, at the request of Mr. Albert J. Perkins. Received March 29, 1910.

Seeds of the following:

27478. CITRUS sp. **Yuzu.**

See No. 26568 for description.

27479. DIOSPYROS KAKI L. f. **Persimmon.**

Mixed seed.

27480. PHYSALIS IXOCARPA Brot. **Husk-tomato.**

From Chico, Cal. Grown at the Plant Introduction Garden from seed which was presented by Mr. Elmer Stearns, Ciudad Juarez, Chihuahua, Mexico. Received March 17, 1910.

"Fruit the size of an English walnut, without shuck. It is very extensively eaten in all parts of the Republic (meaning Mexico). Sow same as any tomato. Plants grow erect, 3 to 4 feet high." (*Stearns.*)

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27018. EMPLEURUM UNICAPSULARIS (L.) Skeels.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., January 5, 1911.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 208 of the series of this Bureau the accompanying manuscript, entitled "Seeds and Plants Imported during the Period from April 1 to June 30, 1910: Inventory No. 23, Nos. 27481 to 28324."

This manuscript has been submitted by the Agricultural Explorer in Charge of Foreign Seed and Plant Introduction with a view to publication.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—541.

SEEDS AND PLANTS IMPORTED DURING THE PERIOD FROM APRIL 1 TO JUNE 30, 1910: INVENTORY NO. 23; NOS. 27481 TO 28324.

INTRODUCTORY STATEMENT.

This quarterly inventory, covering the period from April 1 to June 30, 1910, contains the collections of only one agricultural explorer in the field, Mr. Frank N. Meyer, whose collecting during this period was confined to the mountains of the Caucasus, where he went pending permission from the Russian authorities to enter Chinese Turkestan.

Among the 154 introductions which he found worthy of sending in are the Erivan alfalfa (No. 27980), which the agriculturists in that region have found to be longer lived than the Turkestan variety; a perennial Medicago with large leaves, growing at an altitude of 4,000 feet, which promises to be of use in breeding new strains of hardy alfalfa; a collection of hard-fleshed table grapes, some of which have unusual keeping and shipping qualities (Nos. 27538–27540 and 27620–27650); a dry-land Caucasian beech (No. 27662); scions from wild trees of a shrubby species of pear for use as a dwarfing stock (*Pyrus nivalis elaeagrifolia*, No. 27670); a collection of Caucasian peaches (Nos. 27614–27619); and scions of the true Paradise apple (*Malus pumila*, No. 27968) cut from wild trees, for experiments with the crown gall, which was found by Mr. Meyer very prevalent in the French nurseries of dwarfed apples from which importations are made to America.

Of the plants sent in by correspondents, those experimenting with the different materials used in paper making will be interested in the Japanese species *Abelmoschus manihot* (No. 27493), the mucilaginous juice of which is used by the paper makers of Japan as a size for their handmade papers. A new and delicious fruit introduction by Mr. Walter Fischer, of Para, which he thinks will live in the Everglades, is the Rollinia (No. 27579), which grows on the lowlands along the mouth of the Amazon and occurs in Paraguay (Nos. 27609 and 27797). The Korean chestnut (No. 27587) will be of interest to those who are hunting for resistant species which are immune to the chestnut-tree disease, which is doing such widespread damage. Forage-plant specialists of the New England States will probably wish to test the three selected strains of Norwegian clover, the Molstad, Toten, and Hvinden's, from Roikenvik (Nos. 27600, 27601, and 27602). Fiber experts in Porto Rico, the Philippines, and Hawaii should have their attention called to the Furcraea, from Costa Rica (No. 27777), which is said to have a fiber that is whiter than sisal and is considered of enough importance to be planted on a large scale in Central America. The growing use, especially on the Pacific coast, of the winter muskmelon, or cassaba, makes the introduction of a series of these winter-ripening melons (Nos. 27779–27788) from the Greek islands of Zante and Cephalonia of interest to the melon growers of the Southwest. Although maraschino as a liqueur is well known to Americans, the cherry from which it is made, which is grown on a few small islands in the Adriatic, seems with this introduction to be brought for the first time into America (No. 27791). To those in the Philippines, Hawaii, and Porto Rico who are engaged in the cultivation of rubber trees the introduction of the *Sapium jenmani* of Demerara (No. 27873), from which one of the highest priced rubbers in the world is obtained, can not fail to be of interest. The paint manufacturers, it is learned, import large quantities of euphorbium rosin from Morocco for use in the manufacture of rustless coatings for steel structures, and the introduction of the seed of the euphorbiaceous plant (No. 27955) from the mountain slopes of that country may lead to the creation of a home supply of this material. Seeds have been obtained of the nan mu tree of the Yangtze Valley (No. 28128), which furnishes the most famous of Chinese woods, used in the building of the imperial palaces. As this tree is said to be in danger of extinction and as it will probably grow in our Southern States, the introduction of seeds of it at this time is of special importance. Since the introduction in 1853, from France, of the Chinese sorgo, there seems to have been no reintroduction of that particular strain until this year, when seed of this identical variety (No. 28024) was obtained by correspondence from Tsungming Island, at the mouth of the Yangtze.

Guava cultivation in Florida and Porto Rico for the production of guava jelly has reached a stage when the introduction of a close relative of the guava from Para (*Britoa acida*, No. 28061) will interest a considerable number of people because of its acid fruits. The call on the part of the California growers who supply table grapes to the eastern market for varieties that will better withstand shipment has become insistent and special efforts are being made to meet the demand. A collection of 13 varieties of table grapes from Servia is of interest in this connection (Nos. 27685–27697). For those breeders of the oriental and American persimmon who believe that the cultivation of this fruit plant can be developed into a great orchard industry, a search is being made after all the species of Diospyros which it is thought can contribute to the production of better persimmons, and this inventory contains species from Mauritius, Bengal, the Caucasus, and Mexico.

The total number of introductions listed, 844, is an average of over 280 a month, or 10 introductions each official day, which is more than 16 per cent above the average for any previous period, notwithstanding the fact that only one explorer has been in the field during this time. This may be taken as an indication of the increase in requests from experimenters for new material and in foreign correspondence which leads to the discovery of valuable foreign plants not heretofore introduced.

Special attention is called to the increasing quantity of technical botanical matter included, particularly the geographic distribution of the rarer species. For this, as well as for the determination of the species, Mr. H. C. Skeels, working under the supervision of Mr. Frederick V. Coville, of the Office of Taxonomic and Range Investigations, is responsible. Miss Mary A. Austin, as heretofore, has had charge of the preparation of the inventory.

DAVID FAIRCHILD,
Agricultural Explorer in Charge.

OFFICE OF FOREIGN SEED AND PLANT INTRODUCTION,
Washington, D. C., December 17, 1910.

INVENTORY.

27481. MEDICAGO SATIVA L. **Alfalfa.**

From Westbrook, Minn. Obtained from Mr. Gustave Rasche through Mr. Charles J. Brand. Received April 1, 1910.

"This sample of *Grimm* was produced in the fifteenth year from *Grimm* seed taken to Westbrook from Waconia, Carver County, in 1893. The seed crop of 1909 is the tenth taken from the original planting. Mr. Rasche originally seeded 1 acre, using 15 pounds of seed. In 15 years he has sold about 8 bushels of seed and increased his own acreage to 15. In the severe test at Dickinson, N. Dak., during the winter of 1908–9, this race, grown in rows 3 feet apart, proved to be one of the very hardiest." (*Brand.*)

27482. JUGLANS NIGRA L. **Black walnut.**

From Fresno, Cal. Sent by Mr. George C. Roeding, at the request of Mr. William A. Taylor, to the Plant Introduction Garden, Chico, Cal. Received April 1, 1910.

"I would say that the 'Peanut' black walnut is not a hybrid form, but so far as can be determined is merely an unusual form of the native black walnut, *Juglans nigra*.

"The original tree is a seedling, now 70 or 80 years old, on the land of Mr. H. C. Kline, South Salem, Ohio. The attention of our Mr. W. N. Irwin was called to this tree some years ago by the fact that a large proportion, though not all, of the nuts were very slender and pyriform, quite unlike the usual form of the nut of this species. The kernels in these pyriform nuts are almost cylindrical, only one lobe of the kernel filling and maturing. It is not positively known whether these peculiarly formed nuts come from certain branches of the tree or not. The trees sent to Chico were propagated from scions cut from the original tree two years ago. I quote the following characterization of the variety from the report on nut culture published by the Division of Pomology, in 1896: '*Peanut* (pl. 7, fig. 2).—Received from Mr. W. N. Irwin, South Salem, Ohio. It is a rather small, pyriform nut. Its name was given because of the resemblance of its kernel to that of the peanut. The shell is thin and is easily cracked, while the kernel, which is in the larger end of the nut, comes out entire. The peculiar form is apparently due to some defect in the pistil, as but one side of the nut 'fills' and matures. A large proportion, though not all, of the fruit on the tree is of this form each year. The kernel is white and of delicate flavor.'" (*Taylor.*)

27483. ANONA CHERIMOLA Miller. **Cherimoya.**

From Santa Barbara, Cal. Presented by Dr. F. Franceschi. Received April 6, 1910.

"Fruit from the first tree planted in Santa Barbara some 40 years ago. The fruit when received weighed 13½ ounces; its greatest diameter was 4½ inches, and its least diameter was 3½ inches." (*Franceschi and Dorsett.*)

27484. DIOSPYROS TUPRU Hamilton.

From Lal Bagh, Bangalore, Mysore, India. Presented by Mr. G. H. Krumbiegel, economic botanist, superintendent of the Government Botanic Gardens. Received April 18, 1910.

Distribution.—From the western Himalayas to the plains of Behar in the northwestern part of India.

27485. RHEEDIA EDULIS (Seem.) Planch. and Triana. **Sastra.**

From the Province of Chiriqui, Panama. Procured by the provincial engineer, through Hon. Joseph E. Le Fevre, Secretary of Fomento, Panama City, at the request of Mr. H. F. Schultz. Received April 18, 1910.

"A shrublike tree producing an edible fruit, about 1 to 1½ inches in diameter, which the natives describe as a round berry. It has reddish, smooth skin and a pleasantly acid taste. It is not cultivated, but seems to be well known to the natives. I am informed that the fruit is produced in the dry season, January and February. The tree sends out a long tap root, and this fact discredits the statement made to me by natives that the tree is often found on dry places. 'Dry' places in this country are dry, there is no mistake about this, and if on wet locations, like those on which I found the only three trees I saw, it sends its long tap root down to where the ground is water-soaked every day in the year, it becomes very apparent that this long root is not given the tree in order to hold its own against 'northers' in exposed positions, but merely to go down to a perpetual supply of fresh water." (*Schultz.*)

Distribution.—In dense forests in the vicinity of Remedios, Province of Veragua, Panama. (Seeds.)

27486. CARICA PAPAYA L. **Papaya.**

From New Orleans, La. Presented by Mr. Sam Marshall, superintendent, Audubon Park. Received April 14, 1910.

"These fruits can be pulled as soon as they show a few yellow spots, and are house ripened. They are very much like a muskmelon, being eaten with salt and pepper. This seed was produced by seedling plants that are 2 years old. They are rapid growers, but will not stand any degree of frost. The fruit grows in clusters and is round to oblong in shape. I think they would stand transportation. Have been told they are often to be had in our 'French market'." (*Marshall.*)

27487 to 27489. SOLANUM sp. **Potato.**

From Reading, England. Presented by Messrs. Sutton & Sons. Received April 1, 1910.

Tubers of seed potatoes as follows:

27487. The Congo.
27488. Small white fir apple.
27489. Large red fir apple.

27490. BAMBOS ARUNDINACEA Retz. **Bamboo.**

From Cochin, British India. Presented by Mr. Jean Houzeau de Lehaie, St. Symphorien, Belgium. Received April 2, 1910.

"This species is easily propagated by cuttings by the method described by Rivière.

"Regarding the climatic conditions which it demands, I may say that it has only been sent to Algeria and to Sukhum-Kale, in the Caucasus. It seems to develop best at Sukhum-Kale, though it is colder there than at Algiers. Why, I have no idea. If I am not mistaken, the lowest temperatures met with at Sukhum-Kale are between −3° and −5° C.; temperatures taken with the thermometer sheltered.

27490—Continued.

"The *B. spinosa* (=*B. arundinacea*) grows (when it is vigorous) in the manner best adapted to protect its young stems from herbivora, Rivière says. The stems branch out from the base, and their spiny branches, overhanging to the ground, prevent animals from approaching the trunk and eating the tender young stems. This makes it difficult to establish hedges, for one has to spare the lateral branches from the base in order to protect the young shoots of the following year, and under these conditions transplantation is painful, or else it is necessary to protect the plants during their first years, which is not practicable." (*De Lehaie.*) (Seed.)

27491 and 27492. PUERARIA spp.

From Darjiling, Bengal, British India. Presented by Mr. G. H. Cave, curator Lloyd Botanic Garden. Received April 6, 1910.

Seeds of the following:

27491. PUERARIA PHASEOLOIDES (Roxb.) Benth.

Distribution.—Common in northern and eastern India, Malacca, and the southern part of China.

27492. PUERARIA sp.

27493. ABELMOSCHUS MANIHOT (L.) Medic.

From Yokohama, Japan. Purchased from the Yokohama Nursery Co. at the request of Mr. Charles J. Brand. Received April 6, 1910.

"The root of this plant is used by the Japanese as a size for their handmade papers, which are prepared from the inner bark of *Edgeworthia gardneri* and several varieties of the paper mulberry. The root is macerated in water and added to the paper pulp." (*Fairchild.*)

"The mucilage is obtained from the roots of this plant as follows: Wash off the dirt, soak in fresh water for some hours, and crush them to pieces. The substance thus prepared should then be put in a linen bag and soaked again in water. When the material gets thoroughly soft, the juice comes out of the bag by manipulating in the vat in which pulp has been previously mixed to receive the paste. The bag should be squeezed now and then, as the mucilage does not come out by itself. The paper maker can judge whether sufficient mucilage is in the water or not by its glutinous consistency. This is the best mucilaginous plant extensively used in Japan." (*Yokohama Nursery Co.*) (Seed.)

Distribution.—Scattered throughout the Tropics; naturalized in the southern part of the United States from Florida to Texas.

27494. DIOSPYROS TESSELLARIA Poir.

From Reduit, Mauritius. Presented by Dr. B. Boname, director, Agricultural Station. Received April 6, 1910.

"A tree, or shrub, with alternate, oval, or ovate, glabrous leaves. Flowers densely clustered, sessile, arising from lateral nodules on the young branches. The fruit is edible and is globular or ellipsoidal in form. The wood is valuable." (*Extract from Hiern, Transactions Cambridge Philosophical Society, vol. 12, pt. 1, p. 176.*) (Seed.)

Distribution.—In the forests of the highest parts of the island of Mauritius. Probably produces the ebony of Mauritius; fruits edible.

27495 and 27496.

From Kingston, Jamaica. Presented by Mr. Aston W. Gardner, manager, The Tangley Fruit Co. Received April 7, 1910.

27495 and 27496—Continued.

Cuttings of the following:

27495. Mangifera indica L. **Mango.**

Mazagon. See No. 7042 for previous introduction.

27496. Citrus decumana (L.) Murr. **Pomelo.**

Seedless white variety.

27497. Juniperus pachyphloea Torr.

Collected in the Alamo National Forest, New Mexico. Received through Mr. Raphael Zon, chief of silvics, U. S. Forest Service, April 6, 1910.

See Nos. 24621 and 24624 for previous introductions.

27498 to 27501. Glycine hispida (Moench) Maxim. **Soy bean.**

Grown at Arlington Experimental Farm, Virginia, season of 1909. Numbered for convenience in recording distribution, April 14, 1910.

Seeds of the following. Notes by Prof. C. V. Piper:

27498. "Chromium green; late. Grown under temporary number 0867, from seed found in cowpea No. 23307, from Peking, China."

27499. "Straw yellow; very late. Grown under temporary number 0869, from Mr. W. W. Williams, Ingang, Fukien, China."

27500. "Straw yellow; very late. Grown under temporary number 0888, from Rev. J. M. W. Farnham, Shanghai, China."

27501. "Olive yellow; very late. Grown under temporary number 0889, from Rev. J. M. W. Farnham, Shanghai, China."

27502 to 27504. Vigna unguiculata (L.) Walp. **Cowpea.**

From Coimbra, Portugal. Presented by the Director, Royal Botanic Garden. Received April 6, 1910.

Seeds of the following:

27502. Small black seeded.

27503. Small tan seeded.

27504. Blackeye.

27505. Juniperus procera Hochst. **East African cedar.**

From British East Africa. Procured through Mr. Raphael Zon, chief of silvics, Forest Service, Washington, D. C. Received April 8, 1910.

"East African cedar occurs abundantly in all the drier forests in the mountains of British East Africa at altitudes of from 7,000 to 11,000 feet, and occasionally extending as scattered specimens as low as 5,500 feet. It occurs mainly on the western slopes of the mountains, in what is known as the Kenia Forest, but is entirely absent from the wet southeastern side of the mountains. It appears to attain larger dimensions than any other juniper and often has a tall, straight, mastlike trunk. The largest specimen on record is at an altitude of approximately 9,850 feet, and has a mean diameter of 12 feet 4 inches and contains about 1,546 cubic feet of timber, of which probably about one-third is unsound. The tree has a serviceable bole of 65 feet and a total height of about 110 feet. The trunk forks a short distance from the ground, very likely as the result of fire. The wood is of great value and is scarcely distinguishable from the typical cedar of the familiar lead pencil. It is wonderfully durable in contact with the soil, and old trunks of great age in all stages of slow decay are found throughout the forest. Unfortunately, standing trees are very liable to decay, which detracts considerably from the value of the tree.

27505—Continued.

"The climate of the Kenia Forest varies from wet to very wet. On the south slope the rainfall is estimated at from 80 to 120 inches a year, and on the southeastern side the forest never becomes sufficiently dry to burn. On the western side, where the East African cedar grows, the rainfall is estimated at from 50 to 90 inches a year, the cedar usually being situated in the drier portions of the forest. The temperature, like that of most tropical countries, is comparatively equable with but little difference between mean summer and mean winter temperatures. At altitudes of 6,000 to 8,000 feet the extremes of temperature rarely go below 45° or above 70° F. The region is described as having a typically pleasant and invigorating extratropical climate. There is a rainy season from March to May, during which time it rains heavily, while during the drier season, from December to February, there are usually only occasional showers." (*Compiled from Colonial Report No. 41, East African Protectorate, 1907, by D. E. Hutchins, and the Report on the Forests of British East Africa, 1909, by D. E. Hutchins.*)

"Owing to the climatic conditions under which this tree grows it is doubtful whether it will succeed in this country, except, possibly, in Florida." (*Zon.*)

27506 to 27509. PHASEOLUS LUNATUS L. **Bean.**

From Tamatave, Madagascar. Procured by Mr. William J. Morse, from the Bureau of Manufactures, Department of Commerce and Labor, April 2, 1910.

Seeds of the following:

27506. White.

27507. White with red speck on hilum.

27508. White streaked with red.

27509. White speckled with red.

27510. GARCINIA MANGOSTANA L. **Mangosteen.**

From Buitenzorg, Java. Presented by the Director, Department of Agriculture. Received April 9, 1910.

See No. 25887 for description. (Seed.)

27511. AMYGDALUS PERSICA L. **Peach.**

From Kwangning, Manchuria. Procured by Mr. Edward C. Parker, Bureau of Agriculture, Industry and Commerce, Mukden, Manchuria, from a peach tree in the gardens of Rev. William Hunter. Received April 9, 1910.

27512 to 27517.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, April 6, 1910.

Seeds of the following:

27512. DIOSPYROS LOTUS L.

From Batum, Caucasus, Russia. "(No. 1258a, February 24, 1910.) A wild persimmon growing all through the Crimea and the Caucasus, where the countries border the Black Sea. The small, black fruits are called '*Churma*' and are sold everywhere to the native population as sweetmeats. The Russians in the Caucasus utilize this persimmon as a stock for *D. kaki*, but claim that the grafting or budding is rather difficult. As this species is extremely drought and heat resistant, it is highly recommended as a stock for large-fruited persimmons in regions of the United States where the winters are mild and the summers dry and hot.

27512 to 27517—Continued.

"The trees themselves are ornamental, but the fruits are too small to be ever used by the white races as a dessert." (*Meyer.*)

See also S. P. I. Nos. 17173, 17905 to 17907, 18266, 18599, 19395, 22370, and 22599 for previous introductions.

Distribution.—Southern Europe and Asia; native from the Caucasus region eastward through northern India and central China to Japan; naturalized in the European countries bordering on the Mediterranean.

27513. CICER ARIETINUM L. **Chick-pea.**

From Batum, Caucasus, Russia. "(No. 1259a, February 24, 1910.) These chickpeas are locally called '*Arnout*' and are said to come from the vicinity of Anapa, Northern Caucasus. They are much eaten here by the natives and the Russians, generally boiled in soups or served with meat stews, also roasted and sugared and eaten as a sweetmeat. To be tested especially in the semiarid sections of the United States." (*Meyer.*)

27514. TRITICUM DURUM Desf. **Wheat.**

From Batum, Caucasus, Russia. "(No. 1260a, February 25, 1910.) A winter wheat of first quality, called '*Kriek Bogda;*' said to come from Samsun, Asia Minor; costs 3 rubles per pood in Batum. To be tested in mild-wintered semiarid sections of the United States." (*Meyer.*)

27515. TRITICUM DURUM Desf. **Wheat.**

From Batum, Caucasus, Russia. "(No. 1261a, February 25, 1910.) A winter wheat of second quality, coming from the same locality as the preceding (S. P. I. No. 27514); costs 2.80 rubles per pood in Batum. Recommended for the same localities as the preceding." (*Meyer.*)

27516. GLEDITSIA CASPICA Desf.

From Livadia, Crimea, Russia. "(No. 1262a, January 25, 1910.) A honey locust growing to be a tall tree, found along roads and in thickets, perhaps escaped. A good shade tree for the semiarid sections of the United States where mild winters prevail." (*Meyer.*)

27517. GLEDITSIA CASPICA Desf.

From Nikita, Crimea, Russia. "(No. 1263a, January 24, 1910.) Collected from a tall tree in the Botanical Garden at Nikita. Recommended for the same localities as the preceding number (S. P. I. No. 27516)." (*Meyer.*)

27518. ALEURITES FORDII Hemsl. **China wood-oil tree.**

From China. Purchased from Messrs. L. C. Gillespie & Sons, New York, N. Y. Received April 7, 1910.

See S. P. I. No. 25081 for description.

27519. GREWIA CANA Sond. **"Kafir raisin."**

From Bloemhof District, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, Government agrostologist and botanist, Transvaal Department of Agriculture, Pretoria. Received April 9, 1910.

"This is a common bush of the southwestern Transvaal, about 4,000 feet altitude, subject to light frosts, growing to a height of 4 to 5 feet. It is generally found on outcrops of the dolomite limestone in districts having a rainfall of 20 inches in summer and with a winter drought lasting about six months. The berries are small, but produced in quantity; each contains a large stone, and the percentage of flesh

27519—Continued.

is small. The flesh is sweet, and the berries are eaten by Kafirs and white children. It is possible that the fruit might be improved under cultivation." (*Davy.*) (Seed.)

Distribution.—A branching shrub growing on the mountains in the southwestern part of Transvaal Colony and the northwestern part of Orange River Colony.

27520. CERVICINA UNDULATA (L. f.) Skeels.
(*Campanula undulata* L. f. Suppl. 142. 1781.)
(*Wahlenbergia undulata* DC. Monog. Campan. 148. 1830.)

The genus Cervicina was established by Delile (Fl. d'Egypte, vol. 6, pl. 5) in 1813, the type and only species being *Cervicina campanuloides* Delile. The name Wahlenbergia was apparently first used by Schrader (Cat. Hort. Goetting.), in 1814. This catalogue, which it has not been possible to consult, appears to have contained a mere list of botanical names not accompanied by descriptions, and Wahlenbergia was not, therefore, technically published in that place. The next use of Wahlenbergia is by Roth (Nov. Sp. Ind. Orient. 399), in 1821, where *Wahlenbergia elongata* of Schrader's catalogue is cited and described, and *Campanula capensis* L. cited as a synonym, making it the type of the genus Wahlenbergia. While *Cervicina campanuloides* Delile and *Campanula capensis* L. are very different plants, they are considered by all recent botanical writers to be congeneric, and the name Cervicina, being older, has been used in place of Wahlenbergia by various authors, including Druce (Fl. Berkshire 324. 1897), Hiern (Cat. Welw. Afr. Pl. 1: 631, 1898), and Moore (Journ. Bot. 41: 402. 1903), a precedent which is here followed.

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, Government agrostologist and botanist, Transvaal Department of Agriculture. Received April 9, 1910.

"This plant is said to be much eaten by ostriches, as well as by other stock, including horses. One farmer claims that it is preferred to lucern, and that it keeps green and grows through the dry winter. It is a perennial, and prefers freshly turned, rather moist, sandy soil. It is widely distributed over the eastern Transvaal, from Pretoria eastward, at an altitude of 4,700 to 5,500 feet, with a rainfall of 26 to 33 inches, falling only in summer." (*Davy.*)

Distribution.—Linnæus gives the habitat of *Campanula undulata* as Cape of Good Hope, without locality. The species is found in the coast region of South Africa, extending from the vicinity of Tulbagh, in the southwestern part of Cape Colony, through Uitenhage, the Albany district, and Caffraria, northeastward to the Albert district in Orange River Colony, and to Port Natal in Natal.

27531 to 27537.

From San Giovanni a Teduccio, near Naples, Italy. Purchased from Messrs. Dammann & Co. Received April 11, 1910.

Seeds of the following:

27531 to 27533. DOLICHOS LABLAB L. **Bonavist bean.**

27531. Variety *albus*. **27533.** Variety *sudanensis*.

27532. Variety *atropurpureus*.

27534. DOLICHOS LIGNOSUS L.

27535. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

Brown.

27531 to 27537—Continued.

27536. Capsicum annuum L. **Pepper.**

Sweet Spanish. "A medium-sized, somewhat elongated, nonpungent, sweet form of red pepper, having a highly developed red color and characteristic aroma. It is grown especially in Spain and is ground to form a sort of paprika marked by high color, sweet taste, and lack of pungency. It is hoped that this pepper will do well in this country and that its production may become a small industry here." (*R. H. True.*)

27537. Capsicum annuum L. **Pepper.**

Szegedin Rose paprika or *Hungarian paprika.*

"This form of red pepper belongs to the group of medium-sized, somewhat elongated forms represented by a number of cultivated varieties. Its rather mild pungency, its very deep red color, and rather characteristic aroma combine to produce the commercial article known to the spice trade as *Hungarian* or *Szegedin paprika.* It is prepared for the market in different ways and with different degrees of care and yields paprika differing in quality according as the whole pod, the pod less the seeds, or the mere wall less the seeds and placentae are ground.

"This crop is grown commercially in the neighborhood of Szegedin and Kalocsa, in Hungary. It is ground in Hungary or in Austria and enters foreign commerce chiefly as a powder.

"It has been introduced into South Carolina, where, under the guidance of the Bureau of Plant Industry, U. S. Dept. of Agriculture, a small industry has been established. The yield for 1909 was about 45,000 pounds of dried pods. Owing to the limited demand for the product, this industry is likely to remain a small one, limited to the localities most favored in the matter of soil, climatic and labor conditions." (*R. H. True.*)

27538 to 27540. Vitis vinifera L. **Grape.**

From Quirili, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, April 8, 1910.

Cuttings of the following:

27538. From Quirili, Caucasus, Russia.

"(No. 469, March 1, 1910.) A fine table grape bearing heavy bunches of blue-black fruits. It is of local Caucasian origin and is called '*Dondrelabi,*' much forced in greenhouses in England under the name '*Gros Colmant de Caucase.*' Obtained from the experimental station near Quirili." (*Meyer.*)

27539. From Quirili, Caucasus, Russia.

"(No. 470, March 1, 1910.) A native Crimean variety of table grape, ripening *very* early. It bears the name of '*Schaus.*' The individual berries are of small size, but form long bunches; color, pale yellow; taste, very sweet; a popular variety and much exported. Obtained from the experiment station near Quirili." (*Meyer.*)

27540. From Quirili, Caucasus, Russia.

"(No. 471, March 1, 1910.) A native Caucasian table grape, called '*Kundza.*' Berries and bunches are medium large; color, white; of fresh, sweet taste; stands shipping very well. Recommended as an export table grape for California. Obtained from the experiment station near Quirili." (*Meyer.*)

27541. ELAEAGNUS ANGUSTIFOLIA L.

From Mamuret-ul-Aziz (Kharput), Turkey. Presented by Mr. William W. Masterson, American consul. Received April 8, 1910.

"These are cuttings of the small-seeded variety which over here seem to be more inclined to bush and spread, while those of the larger kind are inclined to go into a heavier growth." (*Masterson.*)

See Nos. 26594 and 26595 for description.

27553 to 27558.

From Choon Chun, Korea. Presented by Mr. J. Robert Moose. Received April 4, 1910.

Seeds of the following:

27553 to 27555. ANDROPOGON SORGHUM (L.) Brot.

27553. **Kowliang.**

Blackhull. "Apparently typical of the variety." (*Carleton R. Ball.*)

27554. **Kowliang.**

Brown. "Seeds rather large; glumes short, transversely shouldered, greenish to reddish brown, glabrous; perhaps a dwarf variety." (*Carleton R. Ball.*)

27555. **Kowliang.**

Brown. "Seeds large; spikelets large, obovate; glumes vary from deep straw color to light brown." (*Carleton R. Ball.*)

27556. CHAETOCHLOA ITALICA (L.) Scribn. **Millet.**

"This millet is the finest variety I have ever seen. It makes fine hay, but is grown here because of its value as a foodstuff for the people; in many parts of the country it is the staple food the year around; it is boiled and eaten instead of rice, and makes an excellent breakfast food. There is big money for the man who will introduce it in the United States, properly prepared as a breakfast food." (*Moose.*)

27557. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

Yellow seeded.

27558. PERILLA FRUTESCENS (L.) Britt.

See No. 22419 for previous introduction.

27559 to 27564.

From Togo, German East Africa. Presented by Mr. G. H. Pape, through Mr. A. B. Conner. Received April 4, 1910.

Seeds of the following:

27559. CANAVALI OBTUSIFOLIUM (Lam.) DC.
27560. CASSIA OCCIDENTALIS L.
27561. CROTALARIA sp.
27562. INDIGOFERA sp.
27563. LOTUS sp.
27564. LOTUS sp.

27566. CITRUS sp.

From Kiaying, China. Presented by Mr. George Campbell. Received April 14, 1910.

"Cuttings of the great Chinese lemon. I saw a specimen which sprawled over a wide space and was said to yield about 150 pounds of fruit every year, mainly used for preserves, or rather, candying, like citron." (*Campbell.*)

27567. ANONA CHERIMOLA Miller. **Cherimoya.**

From Chile. Presented by Mr. Hervey Gulick, Gatico, Chile. Received April 15, 1910.

"This seed is from a tree that I have not seen. The fruit is pear shaped and the size of a large orange, occasionally reaching 6 inches in diameter. The flavor is a little pitchy or piney, but very good. The tree grows in the central part of Chile, also in Peru, semitropical climates. Central California should be suitable for its growth." (*Gulick.*)

27568 to 27570.

From Ceylon, India. Procured by Mr. Albert J. Perkins. Received April 11, 1910.

Seeds of the following:

27568. BOMBAX MALABARICUM DC.

"A large tree with a buttressed base like southern cypress; large maroon flowers, and pods which contain a cotton that is used in making fabrics." (*Perkins.*)

27569. CANAVALI GLADIATUM (Jacq.) DC.

White seeded.

27570. PONGAM PINNATA (L.) W. F. Wight.

Distribution.—A tall, erect tree or climber with glabrous branches and leaves, found in India from the central Himalayas to Ceylon and Malacca, and throughout the Malayan islands to the northern part of Australia.

27571 and 27572.

From Ancon, Canal Zone, Panama. Presented by Mr. N. E. Coffey, quartermaster, Ancon Hospital, at the request of Mr. H. F. Schultz. Received April 18, 1910.

Seeds of the following:

27571. CARYOPHYLLUS JAMBOS (L.) Stokes. **Rose-apple.**

See No. 2941 for description.

Distribution.—Probably native of India; cultivated and naturalized from India to Australia.

27572. CHRYSOPHYLLUM CAINITO L. **Star-apple.**

"One of the most common fruit trees indigenous to the Canal Zone and frequently cultivated in the native (Panama) and West Indian settlements. The trees attain a height of from 25 to 75 feet and are characterized by their magnificent evergreen foliage, dark green above, and aureate, sometimes glaucous, beneath. The fruit is highly prized by the natives, but, on account of the milky and gluelike juice it contains, it is not in as general favor among Americans as its otherwise pleasant taste would indicate. It has the size and appearance of a small apple, globose and regularly 6 to 10 celled, so that, when halved, the inside of the fruit presents a star-shaped formation, each segment containing one seed, rarely, through abortion, none.

"The color of the berry is pale green, blue, or purple; in the case of this introduction the fruit is purple, but it is not supposed to come true to form through seeds. The pulp has a jelly-like consistency and, when fully ripe, a rich yet delicate flavor." (*Schultz.*)

Distribution.—Cultivated and probably native in Panama, Colombia, Peru, Guiana, and the West Indies.

27574. DATURA sp.

From Monterey, Cal. Presented by Mr. H. A. Greene, through Mr. Peter Bisset. Received April 26, 1910.

A supposedly red-flowered variety.

27575. CARICA PAPAYA L. **Papaya.**

From Dongola, Ill. Purchased from the Rose Valley Nurseries, Martin Lewis Benson, proprietor. Received April 23, 1910.

"The female plants of this variety bear a fruit the size of a large muskmelon and are as easily fruited under glass as the tomato. The male plants produce in long racemes and in large clusters enormous quantities of beautiful, waxlike, star-shaped flowers." (*Rose Valley Nurseries.*) (Seed.)

27576 to 27579.

From Para, Brazil. Presented by Mr. Walter Fischer, acting director, Campo de Cultura Experimental Paraense. Received April 25, 1910.

Seeds of the following:

27576. PASPALUM MARITIMUM Trin.

"This grass is the first to take possession of clearings, and is much relished by cattle, and consequently highly valued by the natives. It grows with astonishing rapidity, throwing out runners 20 to 30 feet in length in a very short time. Its height when in flower is 2 to 3 feet. It has a rather thick rhizome, which does not dry out easily, and consequently makes the grass very hard to exterminate when once established. For Florida it would probably make an excellent sand binder and pasture. This grass, according to Dr. Huber, here, has never been named, and it is not known whether it is indigenous or introduced. From its behavior it would appear to be introduced." (*Fischer.*)

Distribution.—In the Provinces of Bahia and Para, in Brazil, and in the Guianas.

27577. AMBELANIA TENUIFLORA Muell. Arg.

"This is called here *Pepino do mato*, i. e., *cucumber of the woods*, or *wood cucumber*. It is a yellow fruit about the size and shape of a small cacao fruit. It contains two seed cavities surrounded by a white flesh of rather firm consistency containing an abundant supply of latex. It is not a fruit that I could recommend very highly. I have not been able to eat it, although it is eaten by the natives." (*Fischer.*)

Distribution.—In the primeval woods along the banks of the Amazon in the Province of Para, Brazil.

27578. RHEEDIA MACROPHYLLA (Mart.) Planch. & Triana.

"*Bacury pary* (pronounced *Bah-coo-reé pah-reé*). This is a yellow or orange-yellow fruit the size of an egg, with a very pronounced beak at the calyx end and filled with four seeds, each surrounded by a very small quantity of agreeable-tasting and refreshing acidulous pulp. This tree is said to be quite common about Para, but as yet I have not seen one, having purchased the fruits on the market. The basketful as I purchased it smelled exactly like a basketful of gooseberries." (*Fischer.*)

Distribution.—French and Dutch Guiana and the valley of the Amazon in the Province of Para, Brazil.

27579. ROLLINIA ORTHOPETALA A. DC.

"This is, as Prof. Baker wrote, the finest anonaceous fruit in tropical America. It is the only one of those which I have tasted that I liked, and on first trial

27576 to 27579—Continued.

I immediately pronounced it delicious. The seeds are enveloped in a large quantity of pulp, which is of a custard-like consistency and of a very agreeable acidulous taste. I do not know what fruit it resembles most in taste. It would undoubtedly do to try in the Everglades, as it grows here in localities which are often flooded for some time during the rainy season." (*Fischer.*)

Distribution.—Paraguay and the adjacent parts of Brazil and Argentina.

27580. SESBAN GRANDIFLORUM (L.) Poir.

From Poona, India. Received through Mr. P. S. Kanetkar, director, Empress Botanic Gardens, April 27, 1910.

"A small tree of very rapid growth, with large flowers and short life. It thrives in any irrigated soil. The flowers and young pods are a favorite vegetable." (*Woodrow's Gardening in India, p. 279.*)

Preparation of *Sesban grandiflorum* as a vegetable: The parts used are: (1) The tender shoots, (2) the fresh flowers, (3) the pods in a tender state, (4) the seeds in tough pods.

The tender shoots are chopped fine, boiled, and the boiled water is thrown away. Salt, chili powder, and "masala," or condiment powder, are added for flavor. Boiling sweet oil (one-half ounce to the pound of vegetable), to which is added asafetida and whole mustard and cumin seeds, is poured on the boiled vegetable. The oil is mixed with the vegetable, which is now kept on a slow fire for seasoning, the pot being covered to condense the steam.

The flowers are washed clean and the standard petal and pistil are taken out of each flower (it is not understood why these are rejected). The chopped flowers are subjected to a slight steaming in a vessel. Afterwards salt, chili powder, and condiment powder are added. From this preparation three different dishes can be made:

(*a*) A sour dish, which is obtained by adding curds and pouring boiled oil (one-half ounce to the pound of vegetable) or ghee, preferably the latter, to which mustard (one thirty-second to one-half ounce of oil), asafetida (5 grains to one-half ounce of oil), and cumin seeds (one thirty-second to one-half ounce of oil) are always added while boiling.

(*b*) Curry can be made from the stuff by adding water, proportionate salt, chili powder, turmeric powder, and a little gram pulse flour to give it consistency. The curry must be well boiled—one-eighth of the water should steam out. Then boiling oil, to which mustard, asafetida, and cumin seeds are added, is poured into the curry. After a little further boiling the curry is ready for use.

(*c*) To the steamed preparation gram pulse flour is added sufficient to make it thick; salt, chili powder, and condiment powder are added and the whole is placed in a vessel on a slow fire to dry off.

The tender pods are cut up into half-inch and inch bits and boiled and then either made into curry like (*b*) or a solid vegetable like (*c*). When made into curry, gram pulse about one-fourth the volume of the bits of pods is boiled with them. A sour dish can also be made from the boiled pod bits like (*a*).

The seeds, before they get tough, are usually mixed with the pod bits when made into curry. No special dish is made from the seeds.

The "masala" (this is a Bombay word) or condiment powder referred to above is made up of the following, fried in sweet oil—2 ounces asafetida, 2 ounces cloves, 2 ounces cinnamon leaves, 2 ounces cinnamon bark, 4 ounces turmeric, 2 pounds coriander, 2 ounces cumin seed, 2 ounces *Carum nigrum*, 2 ounces coconut kernel, 4 ounces sesame.

27580—Continued.

The whole plant has mild purgative properties and the vegetable preparations above described are not much indulged in. (*Kanetkar.*)

Distribution.—Plains of the western peninsula of India and from the island of Mauritius eastward to the northern part of Australia.

27586. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From Honolulu, Hawaii. Presented by Mr. F. G. Krauss, agronomist, Hawaii Experiment Station. Received April 20, 1910.

"*Wilcox.* A cowpea which, so far as I have been able to determine, originated in our trials of 1907, either as a mutant or rogue. As it does not resemble any of the half dozen varieties we have been growing in recent years, I do not think it is a hybrid. It is far ahead of anything we have grown in cowpeas. In the fully developed form, before drying, the pods are a beautiful deep crimson." (*Krauss.*)

27587. CASTANEA sp. **Chestnut.**

From Yokohama, Japan. Purchased from the Yokohama Nursery Co. Received April 11, 1910.

Korean.

27598 and 27599. ZEA MAYS L. **Corn.**

From Mexico. Procured by Mr. Sam E. Magill, American consul, from José Maria M. Sotomayor. Received April 13, 1910.

Seeds of the following:

27598. "*Apepitillado*" produced near Ocatlan.

27599. "*Apepitillado*" produced near Ocatlan by Vidal Gutierrez.

NOTE.—These packages were broken open and the seed probably mixed.

27600 to 27602. TRIFOLIUM PRATENSE L. **Red clover.**

From Roikenvik, Norway. Presented by Mr. Lars Hvinden. Received April 13, 1910.

Seeds of the following:

27600. *Molstad.* **27601.** *Toten.*

"These two clovers are late varieties and should not be grown on marshy soil, but they stand the severest cold for three and four years in Norway." (*Hvinden.*)

27602. *Hvinden's.* "A red clover which I by chance have discovered. It has grown on my farm for years and gave the richest crops I ever saw. It is earlier than *Molstad* and *Toten* clover and can be cut twice in the summer." (*Hvinden.*)

27603 to 27608. MELILOTUS spp.

From St. Petersburg, Russia. Presented by Dr. A. Fischer v. Waldheim, director, Royal Botanic Gardens. Received April 4, 1910.

Seed of the following:

27603. MELILOTUS DENTATA (Waldst. & Kit.) Pers.

27604 to 27606. MELILOTUS INDICA (L.) All.

27607. MELILOTUS ITALICA (L.) Lam.

27608. MELILOTUS MESSANENSIS (L.) All.

27609 and 27610. Rollinia spp.

From Horqueta, Paraguay, South America. Presented by Mr. T. R. Gwynn. Received April 20, 1910.

Seeds of the following; notes by Mr. Gwynn:

27609. Rollinia orthopetala A. DC.

"*Aratecuý Yvirá mató.* A good-sized tree, as large as the orange; is handsome and has splendid foliage. The fruits are small."

Distribution.—Paraguay and the adjacent parts of Brazil and Argentina.

27610. Rollinia emarginata Schlecht.

"*Aratacu-quatu.* This is a small bush growing here in the open camp in almost any soil. The fruit is large and the best class of all according to my thinking."

See No. 25528 for previous introduction.

27611 to 27650.

From Erivan, Caucasus, Russia, close to the frontiers of Persia and of Asia Minor. Received through Mr. Frank N. Meyer, agricultural explorer, who obtained them from the Government Experimental Fruit Garden at Erivan, March 28, 1910. Received April 14 and 30, 1910.

"Erivan is situated at an elevation of 3,229 feet above sea level. The climate is decidedly semiarid with even a slight degree of aridness. The winters are cold with very little snow, the summers hot and dry; there are heavy rains at intervals in the spring and fall. The climate as a whole seems to resemble very much that of the southern Rocky Mountain region. All the crops are irrigated in summer."

Cuttings of the following:

27611. Elaeagnus angustifolia L.

"(No. 711.) A local variety called '*Matna-pshat.*' See note on No. 709 (S. P. I. No. 27775), which is the same. The dried fruits of these 'Russian olives' (as they are called here) are to be found in the native fruit stalls nearly the year round. The trees are mostly seen planted around the fields as windbreaks, the distance between the trees varying from 5 to 15 feet." (*Meyer.*)

27612. Elaeagnus angustifolia L.

"(No. 712.) A local variety called '*Unab-pshat.*' Fruits somewhat smaller than the *Matna-pshat* (S. P. I. No. 27611), skin thicker; not as tender and sweet nor as prolific, but ripens a fortnight earlier and is a better keeper and shipper." (*Meyer.*)

27613. Amygdalus persica L. **Peach.**

"(No. 713.) A native Caucasian variety of peach called '*Salami,*' meaning 'congratulatory.' Fruits large, round, and a little flattened; general color greenish yellow with deep-red cheek; clingstone; large seed; flesh pale yellow with reddish streaks near the stone, juicy and of sweet taste. Ripens the beginning of October." (*Meyer.*)

27614. Amygdalus persica L. **Peach.**

"(No. 714.) A native Caucasian variety of peach called '*Saffrani,*' meaning saffron. The fruits are of medium size; general color saffron yellow, cheek streaked with deep red. The skin has a saffron-like scent. Clingstone. Flesh yellow, juicy, aromatic, and sweet. Ripens in September." (*Meyer.*)

27615. Amygdalus persica L. **Peach.**

"(No. 715.) A local variety of peach called '*Naryndji,*' meaning golden. Fruits large, almost perfectly round; general color golden yellow, blood red on

27611 to 27650—Continued.

sunny side. Flesh of yellow color with red streaks near the stone. Clingstone. Ripens the beginning of October and is a good shipper." (*Meyer.*)

27616. AMYGDALUS PERSICA L. **Peach.**

"(No. 716.) A Caucasian variety of peach called '*Aidinofski.*' Of oblong shape, yellow color. Clingstone. A very late ripener." (*Meyer.*)

27617. AMYGDALUS PERSICA L. **Peach.**

"(No. 717.) A Caucasian variety of peach, called '*Krashni Karmir.*' Fruits very large, color red; clingstone; late." (*Meyer.*)

27618. AMYGDALUS PERSICA L. **Peach.**

"(No. 718.) A Caucasian variety of peach, called '*Aidinof Karmir.*' Fruits very large (like a good-sized apple), of red color; juicy; a late ripener." (*Meyer.*)

27619. AMYGDALUS PERSICA L. **Peach.**

"(No. 719.) A local variety of peach, called '*Norrast-guli.*' Fruits large, of nearly round shape; skin light yellowish green, very downy, medium thick; flesh whitish yellow, very juicy, of aromatic, sour-sweet taste; stone large, cling; kernel sweet like almond. The earliest ripening peach in this locality." (*Meyer.*)

27620 to 27650. VITIS VINIFERA L. **Grape.**

"The grapevines here are planted on ridges 12 to 15 feet apart, with broad furrows running along them, in which the water is allowed to flow. At the approach of cold weather (early November) the vines are covered with loose soil to prevent them from freezing. At the end of March they are uncovered again and pruned. All the Asiatic and Caucasian grapes seem to have to be pruned with long wood to produce the heaviest yields. The many shoots which the plants are allowed to have are trained over the ground, the fruit-bearing stems being put on short forked stakes to prevent the bunches from touching the soil. When trained to wires the grapes shrivel and dry from the great heat. This system, which is very simple and requires but little work, could safely be introduced in those sections of the United States where the winters are too cold for the vinifera type of grapevines to survive unless protected, but where the summers are hot enough to make the grapes ripen. All the vines in the Government garden are grafted on American stock, so as to resist the *Phylloxera.*" (*Meyer.*)

27620. "(No. 720.) A local variety of grape, called '*Ghulabi.*' Bunches long, of very loose and irregular conical shape. Berries round, long, not of uniform size, general color dark pink, covered with a thick coat of white bloom; skin thick, red, and inedible; flesh of pale yellowish-green color, juicy, aromatic, and sweet; few seeds; is used both as a table and wine grape. A prolific bearer. Ripens in the latter part of September and can be kept from two to three months." (*Meyer.*)

27621. "(No. 721.) A Caucasian variety of table grape called '*Shafaï.*' Bunch large, up to 1 foot long, of loose, conical shape. Berries large, irregular, elongated, slightly bent, and not of uniform size; color greenish-yellow with waxy bloom; skin thick, light yellow with a few dark spots around the end; flesh firm, of pale yellow color, not sweet or juicy; seeds always one, seldom two. Ripens at the beginning of October. Can be kept for six months. Does not suffer from *Oïdium.*" (*Meyer.*)

27611 to 27650—Continued.

27622. "(No. 722.) An Asiatic table grape, called '*Ghusaine.*' Bunch 1 to 1¼ feet long, of loose, conical shape, with side bunches. Berries of medium size, elongated, sometimes slightly pressed in on one side. In a bunch there are always a few half-dried berries. They are pale yellow in color, with a whitish bloom; flesh firm, of very sweet and spicy taste. Contains usually two seeds, seldom one. A fine table grape, also used for wine making. Not very prolific, and needs a long season to ripen." (*Meyer.*)

27623. "(No. 723.) An Asiatic table grape, called '*Kishmish.*' Bunch medium size, conical, compact. Berries small, slightly elongated, but less so than red Kishmish; color milk-white with whitish wax bloom and a few red dots; skin white, thick; flesh white with light yellowish hue, juicy and sweet; three rudimentary seeds. Ripens at the beginning of September and is a prolific bearer." (*Meyer.*)

27624. "(No. 724.) A variety of Asiatic table grape, called '*Korsa Kishmish,*' resembles No. 723 (S. P. I. No. 27623) very much, but the color of the berries is less white, the shape irregular, and the fruit ripens earlier." (*Meyer.*)

27625. "(No. 725.) An Asiatic table grape, called '*Kishmish*' (red). Bunch large, long, medium compact, of cylindrical-conical shape, with side bunches. Berries small, egg-shaped, uneven, pink colored, with whitish pink bloom. Skin thin; flesh pale yellow, juicy, and very sweet. Rudimentary seeds only. Ripens about the end of August." (*Meyer.*)

27626. "(No. 726.) An Asiatic table grape, called '*Kishmish daba.*' Said to bear small, compact bunches of small berries; color white; early and prolific." (*Meyer.*)

27627. "(No. 727.) A local variety of table grape, called '*Askari.*' Bunch large, long, of loose, irregular-conical shape with side bunches. Berries small, elongated egg-shaped; color pale green, with a few dark dots. Flesh juicy, not sweet. Ripens near the end of August. A prolific bearer and a very fine table grape, but can not be transported on account of its tender skin, which often breaks open after a rain when fully ripe. Suffers greatly from *Oidium.* Recommended for home use in dry regions with long and hot summers." (*Meyer.*)

27628. "(No. 728.) A table grape called '*Malaki.*' Said to be black, early, and very sweet." (*Meyer.*)

27629. "(No. 729.) A table grape called '*Kizil-sioum.*' Said to be yellow, early, and sweet." (*Meyer.*)

27630. "(No. 730.) A table grape, called '*Mamarsa ghansi.*' Said to be a very good, sweet, black grape. Late." (*Meyer.*)

27631. "(No. 731.) A table grape, called '*Kordash.*' Said to be black, small, and very sweet." (*Meyer.*)

27632. "(No. 732.) A table grape, called '*Danna bazan.*' Said to be black, small, and of subacid flavor." (*Meyer.*)

27633. "(No. 733.) A table grape, called '*Kara-sarma.*' Said to bear large, sweet, black berries. Early." (*Meyer.*)

27634. "(No. 734.) A table grape, called '*Alachki.*' Said to be red, large, sweet, and very early." (*Meyer.*)

27611 to 27650—Continued.

27635. "(No. 735.) A table grape, called '*Esandri.*' Said to be black and very early." (*Meyer.*)

27636. "(No. 736.) A table grape, called '*Esandri.*' Said to be a variety of No. 735 (S. P. I. No. 27635), bearing grapes of a greenish color." (*Meyer.*)

27637. "(No. 737.) A table grape, called '*Chatchabash.*' Said to be yellow; a late ripener, and possessing good transporting and keeping qualities, being kept until February." (*Meyer.*)

27638. "(No. 738.) A table grape, called '*Kharmatmak.*' Said to be yellow and very late." (*Meyer.*)

27639. "(No. 739.) A table grape, called '*Kharashani.*' Said to be white, large, and late." (*Meyer.*)

27640. "(No. 740.) A table grape, called '*Sev-ursa.*' Said to be a large, sweet, black grape, and a late ripener." (*Meyer.*)

27641. "(No. 741.) A table grape, called '*Sgòtoruk.*' Said to be a large black grape, ripening late." (*Meyer.*)

27642. "(No. 742.) A table grape, apparently of local origin, called '*Ghalilou.*' Bunch medium size, medium compact, of elongated-conical shape. Berries small, elongated, elliptical. Color amber yellow. Skin tender, pale yellow, sometimes of rusty color on sun side. Flesh firm, very sweet; a fine dessert grape. Ripens at the beginning of August, the earliest variety in the Erivan district." (*Meyer.*)

27643. "(No. 743.) A table grape, called '*Aldara.*' Said to be large, sweet, and early." (*Meyer.*)

27644. "(No. 744.) A table grape, called '*Shakari-bira.*' Said to be white, large, and round. A very late ripener." (*Meyer.*)

27645. "(No. 745.) A table grape, called '*Shirshira.*' Said to be white, large, and very sweet. Late." (*Meyer.*)

27646. "(No. 746.) A table grape, called '*Aldara.*' Said to be large and black. Late." (*Meyer.*)

27647. "(No. 747.) A local table grape, called '*Rshi-baba.*' Said to be red." (*Meyer.*)

27648. "(No. 748.) A wine grape called '*Chardju.*' Said to be white; bunches small, but dense. Medium late. Produces a fair wine." (*Meyer.*)

27649. "(No. 749.) A local variety of table grape, called '*Ghalilou*' No. 2. Greatly resembles No. 742 (S. P. I. No. 27642), but of a reddish color." (*Meyer.*)

27650. "(No. 750.) A wine grape, called '*Charashani,*' said to be red, and of medium quality." (*Meyer.*)

27651 to 27659. Solanum tuberosum L. **Potato.**

From Bolshaia Viska, Russia. Received from Mr. B. E. Neuberg, through Mr. W. V. Shear, April 19, 1910.

Tubers of the following; descriptive notes by Mr. Shear:

27651. *Vorbote.* "Medium-sized, round to oblong, slightly flattened tubers. Eyes shallow; skin yellowish-white; flesh white. An early variety."

27651 to 27659—Continued.

27652. *Ruby Queen.* "Round to oblong, flattened; skin purple; eyes shallow. Very early."

27653. *Fürst Bismarck.* "Medium-sized, round tubers; skin deep flesh color; eyes shallow."

27654. *Norma, Cimball's.* "Long, cylindrical, medium-sized tubers; skin yellowish; eyes shallow. A medium-early variety."

27655. *Epicure.* "Medium-sized, round to oblong tubers; skin yellowish-white; eyes rather deep. An early variety."

27656. *Entente Cordiale.* "Medium-sized, yellowish-skinned tubers, round to oblong, slightly flattened; eyes shallow. An early variety."

27657. *Cäcilia.* "Tubers medium-sized, oblong, flattened; skin white; flesh yellowish white."

27658. *Imperator, Richter's.* "Medium-sized, oblong, flattened tubers; skin yellowish white; eyes shallow."

27659. *Industrie.* "Medium-sized, oblong, flattened tubers; skin yellowish white; eyes shallow; sprouts white."

27660 and 27661.

From Mayaguez, Porto Rico. Received through Mr. D. W. May, special agent in charge, Porto Rico Agricultural Experiment Station. Received April 19, 1910.

Seeds of the following:

27660. ERYTHRINA UMBROSA H. B. & K.

"This is a most excellent leguminous shade for coffee, and a windbreak for citrus groves." (*May.*)

Distribution.—On the mountains along the coast of Venezuela between La Guayra and Caracas.

27661. STERCULIA FOETIDA L.

See No. 17139 for description.

27662 to 27674.

From Tiflis, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, April 8, 1910.

Seeds of the following:

27662. FAGUS ORIENTALIS Lipsky.

From Tiflis, Caucasus, Russia. "(No. 1286a, Mar. 21, 1910.) The Caucasian beech, which grows to be a tall and imposing tree and forms whole forests all through Caucasus. The wood is excellent material for tubs and barrels, furniture and tools. These seeds came from the vicinity of Yelisavetpol, eastern Caucasus, where there is only a slight annual rainfall (10-12 inches). Recommended as a shade and timber tree for mild-wintered, semiarid sections of the United States. Obtained from Mr. A. C. Rollow, director of the Botanic Gardens at Tiflis. Also see note for No. 406 (S. P. I. No. 26862)." (*Meyer.*)

Distribution.—Throughout the Caucasus region and in the province of Ghilan, northwestern Persia.

27663. ALLIUM CEPA L. **Onion.**

From Tiflis, Caucasus, Russia. "(No. 1287a, Mar. 19, 1910.) A many-headed variety of native Caucasian onion, coming originally from the vicinity of Yelisavetpol, but now also much grown around Tiflis. The curiosity about this

27662 to 27674—Continued.

onion is, as I was informed, that the seeds are sown in the fall in beds or in rows and the young plants left over winter in the open; during the following summer they make a strong growth and produce often five or six onions in a cluster. As Yelisavetpol is situated in a semiarid region, this onion ought to be valuable to settlers in the mild-wintered, semiarid regions of the United States. Obtained from Mr. K. A. Kees, seed dealer, in Tiflis." (*Meyer.*)

27664. CUCUMIS MELO L. **Muskmelon.**

From Tiflis, Caucasus, Russia. "(No. 1288a, Mar. 19, 1910.) Mixed varieties of native Caucasian muskmelons, among which there are said to be some very fine varieties. To be tested in semiarid regions. Purchased in Tiflis." (*Meyer.*)

27665. CUCUMIS SATIVUS L. **Cucumber.**

From Tiflis, Caucasus, Russia. "(No. 1289a, Mar. 19, 1910.) A native Caucasian variety of cucumber, half-long, of green color. Said to be a really good sort, worthy of introduction. To be tested in semiarid regions. Purchased in Tiflis." (*Meyer.*)

27666. SOLANUM MELONGENA L. **Eggplant.**

From Tiflis, Caucasus, Russia. "(No. 1290a, Mar. 19, 1910.) A native Caucasian variety of eggplant. The fruits are of a dark-purple color, elongated shape, and medium size. Considered to be a good sort. For trial in semiarid regions." (*Meyer.*)

27667. TILIA sp.

From Tiflis, Caucasus, Russia. "(No. 1293a, Mar. 22, 1910.) A beautiful native Caucasian shade tree, growing to be very old and of large dimensions. Of value as a park and avenue tree in the mild-wintered sections of the United States. See also No. 408 (S. P. I. No. 26892)." (*Meyer.*)

27668. HALIMODENDRON HALODENDRON (Pallas) Voss.

From Tiflis, Caucasus, Russia. "(No. 1294a, Mar. 14, 1910.) A very spiny shrub, native of the Caucasus, apparently very drought resistant. Suitable as an ornamental garden shrub and as a hedge plant in semiarid regions. Collected in the garden of the School for Horticulture in Tiflis." (*Meyer.*)

Distribution.—The species was described by Pallas from the vicinity of Irtish River in Siberia and is now known to occur from the salt steppes of Transcaucasia to Dzungaria and the Altai region of southern Siberia.

27669. RHAMNUS PALLASII Fisch.

From Tiflis, Caucasus, Russia. "(No. 1295a, Mar. 22, 1910.) An ornamental deciduous shrub, growing on very dry and sterile places. Recommended for bank binding and as an ornamental garden shrub in semiarid, fairly mild-wintered regions. Obtained from the Botanical Garden in Tiflis." (*Meyer.*)

Distribution.—Russian and Turkish Armenia, and the Provinces of Azerbaijan and Ghilan in northwestern Persia.

27670. PYRUS NIVALIS ELAEÀGRIFOLIA (Pall.) Schneider.

From Tiflis, Caucasus, Russia. "(No. 1296a, Mar. 22, 1910.) A shrubby, wild pear, occurring on very dry places, mainly in Eastern Caucasus. Recommended as a dwarfing stock for pears and as an ornamental garden shrub in regions where the winters are not too severe, but the summers hot and dry. Obtained from the Tiflis Botanical Garden." (*Meyer.*)

See No. 27134 for previous introduction.

27662 to 27674—Continued.

27671. Juniperus foetidissima Willd.

From Tiflis, Caucasus, Russia. "(No. 1297a, Mar. 22, 1910.) A tall-growing tree, occurring on dry places. Of value as an ornamental and timber tree in dry regions where fairly mild winters prevail. Obtained from the Tiflis Botanical Garden." (*Meyer.*)

Distribution.—In the coniferous forests on the subalpine and alpine slopes of the mountains of Greece, and in Armenia and the Province of Karabagh in southeastern Russia.

27672. Juniperus oxycedrus L.

From Tiflis, Caucasus, Russia. "(No. 1298a, Mar. 22, 1910.) Obtained from the Tiflis Botanical Gardens." (*Meyer.*)

See No. 26884 for further description.

27673. Juniperus communis L.

From Tiflis, Caucasus, Russia. "(No. 1299a, Mar. 22, 1910.) This well-known shrub, occasionally growing into a small tree, occurs on many places in the Caucasus and is worthy of test as an ornamental evergreen in the semiarid sections of the United States. Obtained from the Tiflis Botanical Garden." (*Meyer.*)

Distribution.—Europe, northern Asia, northern China, the mountains of northern Africa, and in the United States from the Canadian boundary southward to North Carolina, Arizona, and northern California.

27674. Paeonia mlokosewitschi Lomakin.

From Tiflis, Caucasus, Russia. "(No. 1300a, Mar. 22, 1910.) A rare, herbaceous, native Caucasian peony, bearing yellow flowers. Obtained from the Tiflis Botanical Garden." (*Meyer.*)

Distribution.—Slopes of the Caucasus Mountains in the Province of Talysch in southeastern Russia.

27675. MEDICAGO ARABICA (L.) All.

From Sukhum-Kale, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, Mar. 31, 1910.

This was picked out of No. 27343; see this number for remarks.

27676 to 27679.

From Loutulim, Goa, Portuguese India. Presented by Mr. F. S. Cardosa. Received Apr. 16, 1910.

Seeds of the following:

27676. Canavali gladiatum (Jacq.) DC.

27677. Canavali obtusifolium (Lam.) DC.

27678. Dolichos lablab L. **Bonavist bean.**

27679. Mimusops kauki L. **"Adam's-apple."**

See No. 25909 for description.

"This is a very large, hard, timber tree, very productive. Its fruit is a berry about the size of a small egg and is very palatable and delicious when the trees are carefully cultivated." (*Cardosa.*)

27680. CARYOPHYLLUS AROMATICUS L. **Clove.**

From Zanzibar, East Africa. Procured by Mr. Arthur Garrels, American consul. Received Apr. 20, 1910.

"A small tree, 12 to 15 feet high, native in the Molucca Islands, now cultivated widely in tropical regions for the dried, unopened flower buds, which constitute the cloves of commerce. The chief source of cloves is now the island of Zanzibar, where the culture is carried on as a Government monopoly. The unopened flower buds are picked, freed from their stems, and cured for commerce, the original brilliant red of the product changing to a dark-brown color. Cloves contain a pungent, fragrant, volatile oil in great quantity (sometimes as high as 25 per cent), which gives to the product its highly prized quality as a spice. The oil, when separated by distillation, is known to commerce as clove oil, and owing to its properties as an antiseptic and local anesthetic is much used in dental practice. Tannin is present in cloves as high as 17 per cent. They were formerly used as a dyestuff for coloring silks." (*R. H. True.*) (Seed.)

27682 and 27683. ORYZA SATIVA L. **Rice.**

From Philippine Islands. Procured by Mr. William S. Lyon, Manila, P. I. Received Apr. 21, 1910.

Seeds of the following:

27682. MIMIS.

27683. MILAGROSA.

27684. LAUROCERASUS OFFICINALIS Roem. **Laurel-cherry.**

From Tiflis, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer. Received Apr. 23, 1910.

"(No. 485, Mar. 17, 1910.) A variety of laurel-cherry coming from the higher mountains of the Caucasus and able to stand temperatures of 10° below zero F. It is of rather slow growth and low, spreading habits. A good evergreen shrub for parks and gardens in certain sections of the United States, such as Long Island, etc." (*Meyer.*)

27685 to 27703.

From Belgrade, Servia. Presented by the Chief of the Culture Department, Servian Royal Ministry of Agriculture, forwarded through Mr. Robert S. S. Bergh, American consul. Received April 13, 1910.

Cuttings of the following; the information regarding them was translated, from the labels which accompanied the cuttings, by Prof. Woïslav Petrovitch, of the Department of Commerce and Labor, Washington, D. C.:

27685 to 27697. VITIS VINIFERA L. **Grape.**

27685. "*Sitna Bellina.*" Small white grapes, used to make wine.

27686. "*Procoupatz.*" Name derived from that of a town of Eastern Servia, Prokouplie. Used to make wine.

27687. "*Bella Adackalcka.*" "*White Adackalcka.*" For table use.

27688. *White* "*Drenack.*" For table use.

27689. *Red* "*Drenack.*" Long, pointed grapes, for table use.

27690. "*Lipolist.*" Ordinary (common) grapes. Title derived from the similarity of the leaves of this vine and of the linden tree. (In Servian "Lipa"=linden, "List"=leaf.)

27685 to 27703—Continued.

27691. "*Zatchinak.*" Grapes used for wine making in combination with other varieties. ("Zatchinak" means spice.)

27692. "*Plovdina.*" Blue grape used for wine making.

27693. "*Kroupna Bellina.*" Large, round, white grape used for wine making.

27694. "*Skadarka.*" Used for wine making.

Name derived from Lake Skadar of Montenegro.

27695. (Name illegible.) Used for wine making.

27696. "*Smederevka.*" Used for table grapes and wine making.

27697. *Red "Adackalcka.*" For table use.

27698. Cydonia sp. **Quince.**

"*Quince of Leskovatz.*" Leskovatz is a town of southern Servia.

27699. Pyrus sp. **Pear.**

"*Summer Butter-pear.*"

27700. Prunus sp. **Plum.**

"*Servian.*" By this name is known a variety of dark plums that ripen very late in autumn. "Pekmez" (marmalade) is made of them.

27701 and 27702. Mespilus germanica L. **Medlar.**

27701. *Royal.*

27702. "*Vrlo kroupna moushmoula.*" Very large variety.

Distribution.—In the woods of Greece and the Caucasus region, Asia Minor, and western Persia, also occasionally found in the countries of southern Europe, where it is probably introduced.

27703. Cydonia sp. **Quince.**

"*Vranya.*" Vranya is a town in southern Servia.

27704 to 27713.

From Hankow, China. Presented by Mr. A. Sugden.
Received April 14, 1910.

Seeds of the following; notes by Mr. Sugden:

27704. Canavali gladiatum (Jacq.) DC.

27705. Pisum arvense L. **Pea.**

Field variety.

27706. Pisum sativum L. **Pea.**

Field variety.

27707. Glycine hispida (Moench) Maxim. **Soy bean.**

Yellow seeded.

27708. Gleditsia sinensis Lam.

"Grows to be a large tree. Pods used for washing clothes."

Distribution.—The provinces of Chihli, Kiangsu, and Chekiang in the Chinese Empire.

27709. Gymnocladus chinensis Baill.

"Soap is made from this by pounding the pod and is used for washing the person, as it is scented. The seed is used much as we use bluing. The leaf is said to be large and long."

See No. 26281 for previous introduction.

27704 to 27713—Continued.

27710. CUCURBITA PEPO L.

"An ornamental orange gourd, deeply grooved, green at center of ends."

27711. CUCURBITA PEPO L.

"Similar to the above, but deep red."

27712. LAGENARIA VULGARIS Ser.

"Small, yellow gourd which hangs on the plant all winter. Has a fluffy white flower."

27713. SOLANUM MAMMOSUM L.

"Five-finger gourd, from Canton, has large, thorny leaves, and a deep-yellow fruit which lasts on the plant or when picked for a long time, and is both highly ornamental and quaint; there are four small fingers sticking out from the base, on which it is able to stand. The Chinese use it as an ornament. Size of fruit about 3 by 2 inches. Would probably require heat to fruit."

27714 to 27723.

From Tiflis, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, April 20, 1910. Collected by him March 14, 1910.

Cuttings of the following:

27714 to 27719. MORUS ALBA L.

Obtained from the Experiment Station for Sericulture in Tiflis. Suitable for experiment in the mild-wintered semiarid sections of the United States.

27714. "(No. 475.) Variety *pendula*. An interesting variety of the weeping mulberry, making twigs often 10 feet long, which hang straight down. Very beautiful when grafted high, that is, from 10 to 20 feet above the ground. Of value as a cemetery and park tree." (*Meyer.*)

27715. "(No. 476.) Variety *globosa*. An ornamental mulberry, having a dense globular head. May be grafted either high or low and can be used to advantage in gardens where somewhat formal outlines are to be preserved." (*Meyer.*)

27716. "(No. 477.) Variety *pyramidalis*. A robust variety of mulberry, looking, at a distance, very much like a pyramidal poplar. Of value as a lining tree along paths and driveways in places where tall fastigiate trees are not wanted." (*Meyer.*)

27717. "(No. 478.) Variety *latifolia*. A variety of mulberry having large leaves and bearing large, dark berries of good taste, ripening from the middle of June until the middle of September. Of value as an ornamental and fruit tree." (*Meyer.*)

27718. "(No. 479.) Variety *italia*. A very large-leaved variety of mulberry, said to be of Japanese origin. The leaves are unlike other mulberries, being more or less lobed like *Papyrius papyrifera*. The trees are strong growers and may serve as ornamental shade trees, while the dark berries are of a pleasant taste." (*Meyer.*)

27719. "(No. 480.) Variety *hispanica*. A mulberry bearing long, dark berries of a raspberrylike taste. Has large and heavy leaves and may serve as an ornamental tree in parks and gardens." (*Meyer.*)

27720. MORUS NIGRA L.

From Tiflis, Caucasus, Russia. "(No. 481.) A native variety of mulberry bearing the name '*Ghar-tootà*.' Produces large, black berries of a fresh, sweet

27714 to 27723—Continued.

taste, from which excellent preserves can be made. It ripens from the end of July until the middle of September. The trees are apparently slow growers and do not occupy much room. Suggested as a fruit tree for the home garden in those sections of the United States where the winters are not too severe. Obtained from the Experiment Station for Sericulture in Tiflis." (*Meyer.*)

27721. POPULUS ALBA L.

From Tiflis, Caucasus, Russia. "(No. 482.) Variety *pyramidalis.* A tall-growing, very pyramidal poplar, having a very white trunk. Suitable for an avenue tree in the mild-wintered semiarid sections of the United States." (*Meyer.*)

27722. POPULUS ALBA L.

From Tiflis, Caucasus, Russia. "(No. 483.) Variety *Bolleana.* Came originally from Turkestan. Often confused with, yet distinct from, the variety *pyramidalis.* Quite resistant to canker, while the preceding number (S. P. I. No. 27721) is not. Much planted in and around Tiflis." (*Meyer.*)

27723. POPULUS sp.

From Tiflis, Caucasus, Russia. "(No. 484.) A tall poplar of very spreading habits, with silvery white bark. Grows very fast. Apparently a native of the Caucasus. A good park tree for the mild-wintered, semiarid regions of the United States." (*Meyer.*)

27724 to 27736. CITRUS AUSTRALASICA, S. P. I. No. 14993 × CITRUS AURANTIUM?, S. P. I. No. 2886.

Grown at the Department Greenhouse, Washington, D. C., under the supervision of Mr. G. W. Oliver, expert propagator. Numbered April 28, 1910.

"These plants resulted from crossing the finger lime (*Citrus australasica*) with the calamondin. (*C. aurantium* (?)).

"In general appearance the seedlings are intermediate between the two parents. In *C. australasica* the leaves are very small, the petioles being without wings. In the calamondin the winged petioles are quite pronounced. The leaves of the hybrids are much larger than those of *C. australasica;* the petioles of the hybrid, although small, are winged. The seed parent and also the pollen-bearing parent are said to be much hardier than any other edible oranges. It is proposed to use this hybrid in future crossing, both for the production of a hardy orange and also for stocks for the orange and other citrus fruits in the Gulf States.

"The seed from which the female parent was grown was presented to Prof. W. M. Hays, St. Anthony Park, Minn., by Mr. James Pink, Wellington Point, near Brisbane, Australia; this seed was given to the department by Prof. Hays in August, 1905. Mr. Pink says of this species:

"'It is a fruit which I think capable of great improvement. Nothing has ever been attempted with it here, and I send you a few dried fruits which, I have no doubt, contain good seeds. The plant is a large shrub, very limited in its distribution. The fruit when well grown is from 3 to 4 inches long, of a bright orange-crimson color, and of excellent flavor.'

"The pollen-bearing parent was received as *Citrus aurantium* (?) by the Department through Messrs. Lathrop and Fairchild in 1899, from Panama. It is said to have been introduced into Panama from Chile by Mr. Gerardo Lewis. Mr. Walter T. Swingle is of the opinion that it is the calamondin (*Citrus mitis*) of the Philippines." (*Oliver.*)

27737 and 27738. MEDICAGO SATIVA L. **Alfalfa.**

Plants growing at Arlington Experimental Farm, Va. Numbered spring of 1910.

"Two of four surviving plants from an alfalfa field near Weskan, Kans., 20 years old, the rest having succumbed to the extreme drought and encroachment of buffalo grass. These plants were obtained by me under Agrost. No. 42 and 43, summer of 1907." (*J. M. Westgate.*)

27739 to 27754. MEDICAGO FALCATA ♀ × SATIVA ♂. **Alfalfa.**

Hybrids between *Medicago falcata* and various strains and varieties of *Medicago sativa*. Parents selected and hybrids made by Messrs. J. M. Westgate and W. J. Morse at the Arlington Experimental Farm during the summer of 1908. Numbered spring of 1910.

27739. Agrost. No. 2111. (*Medicago falcata* [S. P. I. No. 20718] crossed with Peruvian alfalfa [Agrost. No. 2002] [S. P. I. No. 14972?].) First plant in row.

27740. Agrost. No. 2111. Second plant in row.

27741. Agrost. No. 2111. Third plant in row.

27742. Agrost. No. 2112. (*Medicago falcata* [Agrost. No. 2072] [S. P. I. No. 19534] crossed with *Medicago sativa* [Agrost. No. 18, a heavily seeded upright selection].) First plant in row.

27743. Agrost. No. 2113. (Same parent plants as Agrost. No. 2112.) First plant in row.

27744. Agrost. No. 2160. (*Medicago falcata* [S. P. I. No. 20718] crossed with *Medicago sativa* [S. P. I. No. 20775]). First plant in row.

27745. Agrost. No. 2161. (Same parent plants as Agrost. No. 2160.) First plant in row.

27746. Agrost. No. 2161. Second plant in row.

27747. Agrost. No. 2112. Second plant in row.

27748. Agrost. No. 2112. Third plant in row.

27749. Agrost. No. 2112. Fourth plant in row.

27750. Agrost. No. 2112. Fifth plant in row.

27751. Agrost. No. 2113. Second plant in row.

27752. Agrost. No. 2113. Third plant in row.

27753. Agrost. No. 2113. Fourth plant in row.

27754. Agrost. No. 2113. Fifth plant in row.

27764. ANDROPOGON SORGHUM (L.) Brot. **Sorgo.**

From Scott City, Kans. Purchased from Mr. J. K. Freed. Received April, 1910.

"Mr. Freed states that he has grown this variety for three or four years, but its origin is unknown to him. He finds it ten days earlier than ordinary *Amber* sorgo, but he plants a little more seed to the acre. In seed yield it outyields ordinary *Amber* fully 50 per cent. The following description is by Mr. Carleton R. Ball:

"'Stalk slender, 5½ to 6 feet tall; butts one-half inch to 1 inch in diameter; internodes long and slender; leaves 8 to 10; panicles well exserted, pyramidal to open oblong—the pyramidal rather sparse, the oblong more dense; rachis continuous; spikelets obovate; glumes straw colored, smooth to hairy; seeds rather obovate, pure white.'

"Mr. Ball further suggests that this may be identical with the variety cultivated many years ago under the name of '*White Seeded* or *White India*.'" (*C. V. Piper.*)

27765 to 27767.

From Mazatlan, Mexico. Presented by Dr. J. N. Rose, associate curator, Division of Plants, Smithsonian Institution, United States National Museum, Washington, D. C. Received April 23, 1910.

Seeds of the following; notes by Dr. Rose:

27765. Bromelia sp.

(Rose No. 13982.)

27766. Bromelia sp.

(Rose No. 13983.)

"These seem to represent different species. The fruit is sold in the market at Mazatlan."

27767. Acrocomia mexicana Karw.

"(Rose No. 13969.) A tall tree growing in low ground, fruit common in the markets in April and May. The fruits after being peeled are cooked in sugar and eaten by the poorer classes." (*Rose.*)

Distribution.—In damp woods along both coasts of tropical Mexico.

27768. Pterocarya fraxinifolia (Lam.) Spach.

From Elk Grove, Cal. Presented by Messrs. Tribble Bros., through Mr. Peter Bisset. Received April 28, 1910.

"An ornamental deciduous tree, attaining a height of 60 feet, of rapid growth, with spreading branches, graceful, dark-green foliage, decorated in summer and fall with the long, drooping racemes of light-green fruits. Is hardy as far north as Massachusetts. It thrives best in rich and moist soil, but also grows in drier localities. Propagated by seed and by layers and suckers." (*Extract from Bailey's Cyclopedia of American Horticulture.*)

Distribution.—In woods in the regions bordering on the southern shores of the Black and Caspian seas and in the northern part of Persia.

27769 to 27775.

From Tiflis, Caucasus, Russia. Obtained from the Botanic garden by Mr. Frank N. Meyer, agricultural explorer. Received April 26, 1910.

Cuttings of the following:

27769. Malus sylvestris Miller. **Apple.**

From Tiflis, Caucasus, Russia. "(No. 488, Mar. 22, 1910.) A native Caucasian variety of apple, called '*Pschacha Chis.*' A winter apple excellently fitted for keeping and transport. Suitable for regions where dry and hot summers prevail." (*Meyer.*)

27770. Pyrus communis L. **Pear.**

From Tiflis, Caucasus, Russia. "(No. 492, Mar. 22, 1910.) A native Caucasian variety of pear, called '*Dilafruz.*' Suitable for regions like No. 488 (S. P. I. No. 27769)." (*Meyer.*)

27771. Prunus avium L. **Cherry.**

From Tiflis, Caucasus, Russia. "(No. 702, Mar. 22, 1910.) A native Caucasian variety of cherry, called '*Sari Gilaz.*' Fruits large, heart shaped, slightly compressed from the sides; color yellow; flesh light yellow, slightly translucent; taste sour-sweet; stone large, slightly oval, easily separated from pulp. Ripens at beginning of June. A very prolific bearer. Suitable for regions like No. 488 (S. P. I. No. 27769)." (*Meyer.*)

27769 to 27775—Continued.

27772. PUNICA GRANATUM L. **Pomegranate.**

From Tiflis, Caucasus, Russia. "(No. 706, Mar. 22, 1910.) A native Caucasian variety of pomegranate, called '*Schirin nar.*' Fruits of medium size, globular, compressed on the sides. Rind light red; flesh rosy white, sweet. A medium-prolific bearer." (*Meyer.*)

27773. PUNICA GRANATUM L. **Pomegranate.**

From Tiflis, Caucasus, Russia. "(No. 707, Mar. 22, 1910.) A native Caucasian variety of pomegranate, called '*Cumzi gabuch.*' Fruits very large; rind thick, red; flesh dark red, juicy, of sour-sweet taste; seeds large. A very prolific bearer. A sour-sweet sirup, called '*Nardashi,*' is prepared from the fruits with grape juice added." (*Meyer.*)

27774. PUNICA GRANATUM L. **Pomegranate.**

From Tiflis, Caucasus, Russia. "(No. 708, Mar. 22, 1910.) A native Caucasian variety of pomegranate, called '*Savalan Nar.*" (*Meyer.*)

27775. ELAEAGNUS ANGUSTIFOLIA L. **Oleaster.**

From Tiflis, Caucasus, Russia. "(No. 709, Mar. 22, 1910.) One of the best and most prolific varieties, called '*Matna-pshat.*' Fruits large, nearly cylindrical in shape; color yellowish gray, sun side dark red. Skin very thin, easily peeled off from the fruit when fully ripe. Flesh light grayish yellow, tender, and sweet. Eaten fresh or dried as a dessert, also stewed in milk as an invigorating food, or boiled with sugar as a compote. Recommended as a fruit for the home garden in the mild-wintered, rather arid sections of the United States." (*Meyer.*)

27776. CITRUS BERGAMIA Risso. **Bergamot orange.**

From Bronte, Sicily. Presented by Mr. Charles Beek, manager for the Duke of Bronte. Received April 28, 1910.

See No. 25544 for previous introduction.

27777. FURCRAEA CABUYA INTEGRA Trelease. **Cabuya blanca.**

From San Ramon, Costa Rica. Received from Mr. G. C. Worthen, through Mr. Lyster H. Dewey, April 28, 1910.

"A fiber plant native in Central America and now beginning to be cultivated on large plantations in Costa Rica. It grows on the dry highlands, and in some places at altitudes of 8,000 feet. It is occasionally subjected to temperatures in the winter nearly as low as freezing. A fiber, similar in character to sisal, but whiter and somewhat stronger than the sisal from the henequen, is produced in the leaves. This fiber may be cleaned by the same kind of machinery as that used for sisal. The plant is recommended only for Porto Rico, Hawaii, and possibly the Florida Keys." (*Dewey.*)

27778. TRIPHASIA TRIFOLIATA (L.) DC.

From Mazatlan, Mexico. Presented by Dr. J. N. Rose, associate curator, Division of Plants, U. S. National Museum, Washington, D. C. Received April 23, 1910.

"Grown as an ornamental tree at Mazatlan; 20 feet high; flowers white, fragrant; fruit small, red." (*Rose.*)

See No. 21284 for previous introduction.

Distribution.—Native locality not known; naturalized and cultivated in India, Cochin China, and most other tropical countries.

27779 to 27788. CUCUMIS MELO L. **Muskmelon.**

From Greece. Presented by Mr. Alfred L. Crowe, British vice consul, Zante, Greece. Received April 20, 1910.

Seed of the following; notes and names by Mr. Crowe:

27779 to 27784. From Cephalonia.

27779. *Bekeeria.* Large winter melon.
27780. *Cassaba.*
27781. *Black Cassaba.*
27782. *Good Cassaba.*
27783. *Black.*
27784. Winter melon.

27785 to 27788. From Zante.

27785. (No name.)
27786. White.
27787. Red.
27788. (No name.)

"*Directions for planting.*—The ground must be most carefully prepared (almost sifted) to a depth of about half a fathom (3 feet); then divided into 3-foot squares. In these squares horse dung or other pure animal manure, such as dung of goat or sheep, at least 2 years old, and well hand picked, is spread with the hand in each square at a depth of about 25 inches. Throw about 20 pounds of manure in each square and cover with a little earth, over which put another 10 pounds of manure and cover again with good earth. Plant the seed with the fingers at the depth of about 2 to 2½ inches. The best season for planting is the middle of April. Before planting the seed put it in thin muslin, well tied, and then in a plate or dish full of water, in which you leave it for about twenty-four hours to soak; then bury the seed, as it is in the muslin, in manure until it begins to sprout, when it is ready to plant." (*Crowe.*)

27789 to 27790. CHRYSOPHYLLUM CAINITO L. **Star-apple.**

From Culebra, Canal Zone, Panama. Presented by Mr. Alfred Dyer. Received April 28, 1910.

"This seed is from the same variety, but from different localities." (*Dyer.*)

See No. 27572 for description.

27791. PRUNUS CERASUS MARASCA (Host) Schneider. **Marasca cherry.**

From Dalmatia. Purchased from Mr. Ludwig Winter, Bordighera, Italy. Received May 2, 1910.

"The term '*Maraschino*' or '*Marasco*' is the name of a liquor which is distilled from cherries. This appears to be a well-known product in Dalmatia, and possibly also in other portions of southern Europe. The cherries used for this purpose are commonly known as '*Maraschino*' cherries. This name, also the names '*Marasquin*,' '*Marasca*,' and '*Marasco*,' are given by Le Roy, a leading French pomological authority, as synonyms of a variety the accredited name of which in France appears to be '*Griotte á Ratafia* (*Petite*).' This name signifies a liquor made from small black cherries. Whether in popular usage the name '*Maraschino*' is applied to other varieties than this one does not appear." (*H. P. Gould.*)

"The exact botanical status of the Maraschino cherry is uncertain. It has been variously placed by different botanists, some considering it a form of *Prunus cerasus*, while others look upon it as a form of *P. acida*. Still others have classified it otherwise." (*W. F. Wight.*)

27792. Acacia decurrens Willd. **Black wattle.**

From Berea, Durban, Natal, South Africa. Presented by Dr. J. Medley Wood, director, Botanic Garden. Received May 2, 1910.

Distribution.—Along river banks and on mountain slopes in the provinces of Queensland, New South Wales, Victoria, and South Australia in Australia, and in the island of Tasmania.

27793. Carica papaya L. **Papaya.**

From Tlacotalpan, Vera Cruz, Mexico. Presented by Mr. Edward Everest, Hda. "La Candelaria." Received May 2, 1910.

"These seeds were taken from a very sweet, good fruit." (*Everest.*)

27794 to 27796. Medicago spp.

From Paris, France. Presented by The Director, Paris Museum of Natural History, at the request of Mr. C. V. Piper. Received May 2, 1910.

Seed of the following:

27794. Medicago carstiensis Wulfen.

Distribution.—In open grassy places or in thickets in the southern part of Austria, especially in Istria, Croatia, Bosnia, and Dalmatia.

27795 and 27796. Medicago hispida denticulata (Willd.) Urban.

27797. Rollinia sp.

From Horqueta, Paraguay, South America. Presented by Mr. T. R. Gwynn. Received April 27, 1910.

"Chirimoya chica colorado. This is a small red fruit, growing on a bush, and to my taste the best of all the varieties." (*Gwynn.*) (Seed.)

27798. Inga edulis Mart.

From Para, Brazil. Presented by Mr. Walter Fischer, acting director, Campo de Cultura Experimental Paraense. Received May 6, 1910.

"This is known as *Ingá cipó.* 'Cipó' here is the word for liane, given to the fruit undoubtedly on account of its curious appearance and resemblance to a liane. It is from 1 foot to 2 feet in length and about the thickness of a man's thumb, or even thicker, usually twisted and crooked. The seeds are surrounded by a pulp in texture something like that of *Theobroma grandiflorum.* This pulp is acidulous, but has little flavor." (*Fischer.*)

Distribution.—Mexico, from the vicinity of Vera Cruz, southward through Central America to the valley of the Amazon in Brazil.

27801 to 27813.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, April 30, 1910.

Seeds of the following:

27801. Hordeum sp. **Barley.**

From Tiflis, Caucasus, Russia. "(No. 1302a, Mar. 20, 1910.) A sample of black winter barley used locally for horse feed (see S. P. I. No. 27829). Obtained from Mr. Eiranoff, secretary of the Agricultural Society in Tiflis." (*Meyer.*)

27801 to 27813—Continued.

27802. HALOXYLON AMMODENDRON (Meyer) Bunge. **Saxaul.**

From Tiflis, Caucasus, Russia. "(No. 1303a, Mar. 22, 1910.) A tree or tall shrub resisting alkali and aridness to a most remarkable degree. In certain sections of central Asia it is practically the only tree to be found and its wood is much used for fuel. Recommended as a windbreak and a fuel supply for the desert regions of the southwestern part of the United States. Obtained from the Tiflis Botanic Garden, the only botanic garden in the world where a plantation of this remarkable tree exists." (*Meyer.*)

See S. P. I. No. 24555 for previous introduction.

27803. MEDICAGO SATIVA L. **Alfalfa.**

From Erivan, Caucasus, Russia. "(No. 1304a, Mar. 28, 1910.) A robust form of alfalfa (Alfalfa passes here under the Tartar name '*Yondjin*'). This variety may prove of value in the southern Rocky Mountain regions where the climate very much resembles that of Erivan. For general climatic information for this and other numbers from Erivan see note on Nos. 711 to 750 (S. P. I. Nos. 27611 to 27650)." (*Meyer.*)

27804. CITRULLUS VULGARIS Schrad. **Watermelon.**

From Erivan, Caucasus, Russia. "(No. 1305a, Mar. 28, 1910.) Mixed local varieties reputed to be of fine quality. There are said to be red and yellow ones among these. To be tested under irrigation in the hot-summered, arid, and semiarid sections of the United States." (*Meyer.*)

27805. CUCUMIS MELO L. **Muskmelon.**

From Erivan, Caucasus, Russia. "(No. 1306a, Mar. 28, 1910.) A celebrated local variety of muskmelon, called '*Dootma*,' said to be very fine. To be tested like No. 1305a (S. P. I. No. 27804)." (*Meyer.*)

27806. CUCUMIS SATIVUS L. **Cucumber.**

From Erivan, Caucasus, Russia. "(No. 1307a, Mar. 28, 1910.) A local variety of cucumber, half long, green, trained on stakes. To be tested like No. 1305a (S. P. I. No. 27804)." (*Meyer.*)

27807. RAPHANUS SATIVUS L. **Radish.**

From Erivan, Caucasus, Russia. "(No. 1308a, Mar. 28, 1910.) A local variety of radish, large, round, and of bright-red color. A spring vegetable. To be tested like No. 1305a (S. P. I. No. 27804)." (*Meyer.*)

27808. RAPHANUS SATIVUS L. **Radish.**

From Erivan, Caucasus, Russia. "(No. 1309a, Mar. 28, 1910.) A local variety of radish, large, long, and of white color. A spring vegetable. To be tested like No. 1305a (S. P. I. No. 27804)." (*Meyer.*)

27809. ALLIUM CEPA L. **Onion.**

From Erivan, Caucasus, Russia. "(No. 1310a, Mar. 28, 1910.) A Caucasian variety of white winter onion, very sweet and rather solid. To be tested like No. 1305a (S. P. I. No. 27804)." (*Meyer.*)

27810. ABELMOSCHUS ESCULENTUS (L.) Moench. **Okra.**

From Erivan, Caucasus, Russia. "(No. 1311a, Mar. 28, 1910.) A native Caucasian variety of okra, said to be fine. This vegetable passes here under the Tartar name of '*Pam-ya.*' To be tested like No. 1305a (S. P. I. No. 27804)." (*Meyer.*)

27801 to 27813—Continued.

27811. Lepidium sativum L.

From Erivan, Caucasus, Russia. "(No. 1312a, Mar. 28, 1910.) A native vegetable called in the Tartar language '*Kodim*,' apparently a broad-leaved variety of the garden cress. It is grown out in the open, on protected places, throughout the winter, and eaten raw as a salad with meats. Recommended as a winter green in the southern United States." (*Meyer.*)

27812. Ocimum basilicum L.

From Erivan, Caucasus, Russia. "(No. 1313a, Mar. 28, 1910.) A Caucasian summer vegetable, called in the Tartar language '*Rahan*.'" (*Meyer.*)

Distribution.—Probably native in the Punjab regions of India; generally cultivated as a pot herb.

27813. Satureja hortensis L.

From Erivan, Caucasus, Russia. "(No. 1314a, Mar. 28, 1910.) A Caucasian summer vegetable, said to grow only a few inches high, called in the Tartar language '*Marza*.'" (*Meyer.*)

Distribution.—The countries bordering on the Mediterranean; frequently cultivated in kitchen gardens.

27814 to 27829.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, April 28, 1910.

Seeds of the following:

27814. Cicer arietinum L. **Chick-pea.**

From Tiflis, Caucasus, Russia. "(No. 1273a, Mar. 19, 1910.) A variety of chick-pea, said to come from the vicinity of Gori, central Caucasus. There are apparently several strains in this lot. These chick-peas remain somewhat hard, even after being boiled a long time. See note on No. 1259a (S. P. I. No. 27513)." (*Meyer.*)

27815. Cicer arietinum L. **Chick-pea.**

From Tiflis, Caucasus, Russia. "(No. 1274a, Mar. 19, 1910.) A variety of chick-pea, said to come from Cacheti, central Caucasus. Considered a finer variety than the preceding and becomes quite soft when boiled. See note on No. 1259a (S. P. I. No. 27513)." (*Meyer.*)

27816. Lens esculenta Moench. **Lentil.**

From Tiflis, Caucasus, Russia. "(No. 1275a, Mar. 19, 1910.) This lentil is eaten by the natives boiled in soup, and although small, is said to have a much finer taste than the large ones. In America this legume may perhaps be of value as a fodder or cover plant in the semiarid sections." (*Meyer.*)

27817. Phaseolus coccineus L.

From Tiflis, Caucasus, Russia. "(No. 1276a, Mar. 19, 1910.) A large white bean, said to grow in Kherson Government, southwest Russia, where the climate is warm and rather dry in summer. These beans are much eaten by Jewish residents in Russia. To be tried in the semiarid sections of the United States." (*Meyer.*)

27818. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1277a, Mar. 19, 1910.) A round, yellow bean, said to be early; comes from the Kherson Government, southwest Russia. To be tried in semiarid sections of the United States." (*Meyer.*)

27814 to 27829—Continued.

27819. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1278a, Mar. 19, 1910.) A round, white bean, said to be very productive; comes from the Kherson Government in southwest Russia. To be tried in semiarid sections of the United States." (*Meyer.*)

27820. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1279a, Mar. 19, 1910.) A small, white bean; comes from the Kherson Government, southwest Russia. Much eaten by Jewish residents in Russia. To be tried in semiarid sections of the United States." (*Meyer.*)

27821. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1280a, Mar. 19, 1910.) A long, white bean, native to this section of the Caucasus. To be tried in semiarid sections of the United States." (*Meyer.*)

27822. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1281a, Mar. 19, 1910.) A round, speckled bean, native to the Caucasus and often seen exposed for sale. To be tried in semiarid sections of the United States." (*Meyer.*)

27823. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1282a, Mar. 19, 1910.) A long, speckled bean, native to the Caucasus. To be tried in semiarid sections of the United States." (*Meyer.*)

27824. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1283a, Mar. 19, 1910.) A handsome, long, red bean. An old native Caucasian variety said to come from Vladikavkas. Very much liked by the natives who use beans in summer instead of meats. To be tried in semiarid sections of the United States." (*Meyer.*)

27825. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1284a, Mar. 19, 1910.) A round, thick, dark-red bean, native to the Caucasus. Much eaten by the native population. To be tried in semiarid sections of the United States." (*Meyer.*)

27826. Phaseolus vulgaris L.

From Tiflis, Caucasus, Russia. "(No. 1285a, Mar. 19, 1910.) A flat, red bean, native to the Caucasus. To be tried in semiarid sections of the United States." (*Meyer.*)

27827. Panicum miliaceum L.

From Tiflis, Caucasus, Russia. "(No. 1291a, Mar. 22, 1910.) A large-grained, white proso, considered to be the best variety in Tiflis. To be tested in regions with a limited rainfall. Purchased in Tiflis." (*Meyer.*)

27828. Panicum miliaceum L.

From Tiflis, Caucasus, Russia. "(No. 1292a, Mar. 22, 1910.) A reddish proso, said to be very drought resistant. Purchased in Tiflis, in the vicinity of which it grows. To be tried in semiarid regions." (*Meyer.*)

27829. Hordeum vulgare nigrum (Willd.) Beaven. **Black barley.**

From Tiflis, Caucasus, Russia. "(No. 1301a, Mar. 23, 1910.) This is grown in the vicinity of Tiflis, mostly as a winter grain, and extensively used as a feed for horses instead of oats, as the last do not grow well in the Caucasus. This barley is generally soaked over night before being fed to the animals." (*Meyer.*)

27830 to 27838. MANGIFERA INDICA L. **Mango.**

Grown at the Department Greenhouse, Washington, D. C. Numbered May 3, 1910.

Plants of the following seedling Philippine mangos, selected for propagation by grafting, for distribution and testing, to determine how nearly these varieties come true from seed:

27830 and 27831. *Carabao.* Grown from S. P. I. No. 25938.

27832 to 27834. *Pico.* Grown from S. P. I. No. 25939.

27835 to 27838. *Lyon.* Grown from S. P. I. No. 25940, which was introduced under the class name of *Pahutan.*

27839 to 27842.

From Callao, Peru, South America. Presented by Rev. V. M. McCombs. Received May 5, 1910.

27839. SOLANUM sp. **Potato.**

Yellow. (Tubers.)

27840 and 27841. ANONA CHERIMOLA Miller. **Cherimoya.**

27840. (Seeds.) **27841.** (Cuttings.)

27842. LUCUMA sp. (Seeds.)

27843 to 27845.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, May 3, 1910.

27843. IRIS sp.

From near Helenendorf, Caucasus, Russia. "(No. 769, Apr. 8, 1910.) An iris, perhaps *I. paradoxa*, found on a dry, stony mountain slope, and growing but a few inches high. May be of value as a low-growing edging plant in semiarid regions." (*Meyer.*) (Rhizomes.)

27844. GLADIOLUS SEGETUM Gawl.

From near Geok-Tepe, Caucasus, Russia. "(No. 770, Apr. 12, 1910.) A wild gladiolus occurring on dry mountain slopes. To be tested in breeding experiments." (*Meyer.*) (Bulbs.)

Distribution.—From the Madeira and Canary Islands eastward through northern Africa and southern Europe to Persia and Turkestan.

27845. TULIPA EICHLERI Regel.

From near Geok-Tepe, Caucasus, Russia. "(No. 771, Apr. 12, 1910.) An ornamental species of tulip having large, bright-red flowers that stand on long stems. Found growing on dry places in the mountains at several hundred feet elevation." (*Meyer.*)

Distribution.—In the vicinity of Baku in the Transcaucasian region and in the Kohrud Mountains of northern Persia.

27846 and 27847. MALUS SYLVESTRIS Miller. **Apple.**

From Santa Ines, Chile. Presented by Mr. Salvador Izquierdo. Received May 2, 1910.

Cuttings of the following:

27846. *Admirable de Otono de Santa Ines.* "This tree produces a large fruit, somewhat flattened; color green, inclined to yellow, with vertical, reddish stripes; fruit sweet, acidulous, juicy, and very aromatic; an excellent variety; ripens here at the end of April. The tree is very vigorous and absolutely unattackable by the woolly aphis. I consider it an excellent market fruit." (*Izquierdo.*)

27846 and 27847—Continued.

27847. *Huidobro.* "This is known, also, to the few people who have it, as *Araucana.* It is, perhaps, the most valuable winter apple, since it is absolutely immune to the woolly aphis and other pests. It is a vigorous and prolific tree, produces a large uniformly golden-yellow fruit, which keeps until October or November in Chile. Of very characteristic taste and consistency, such as is found in no other apple of the collection at Santa Ines. It will be of great value for the planting of commercial orchards, as its fruit is firm and ships well. The horticulturist who created this variety thinks he has made a valuable addition to our fruit trees. It originated from an Italian seed sown in Chile at 'Principal,' the estate of Señor Vicente G. Huidobro." (*Extract from Publicaciones de la Estacion de Patolojia Vejetal de Chile, No. 3. El Pulgon Lanijero de los Manzanos by Gaston Lavergne. p. 6.*)

27848 and 27849. MANGIFERA INDICA L. **Mango.**

From Kingston, Jamaica. Purchased from the Tangley Fruit Co., Mr. Aston W. Gardner, manager. Received May 5, 1910.

Seeds of the following:

27848. *Maharajah.* "Fruit roundish oblique, flattened, $4\frac{1}{8}$ by $3\frac{3}{16}$ by $2\frac{7}{8}$ inches. Cavity shallow, with a distinct suture extending 2 inches from stem. Beak, medium, about 1 inch from end of fruit. Surface, moderately smooth, some fine undulations. Color, greenish yellow, shading to rich yellow. Dots, very numerous, yellow. Skin, thick, tenacious. Flesh, rich yellow, tender, but very fibrous. Flavor, sweet, pleasant quality, if fiber was not so abundant would be good. Seed, flat, oval, covered with a dense coat of fiber, medium size 3 by $1\frac{11}{16}$ by 7/8 inch." (*William A. Taylor.*)

27849. *Mangalore.* "Fruit oblong, oblique, flattened, $4\frac{1}{16}$ by $3\frac{5}{8}$ by $2\frac{5}{8}$ inches. Cavity, shallow, small furrows without suture. Stem, very slender, with bracts. Beak, small, one-sixteenth inch above general surface, seven-eighths inch from end center. Surface, moderately smooth. Color, yellow, with marblings of green. Dots, numerous, yellow. Skin, thick, tenacious. Flesh, deep yellow, tender except for fiber, juicy. Flavor, mild, subacid, quality good. Seed, flat, oval, $3\frac{1}{2}$ by $2\frac{1}{8}$ by 7/8 inch." (*William A. Taylor.*)

27850 to 27855.

From Port Louis, Mauritius. Presented by Mr. G. Regnard. Received May 6, 1910.

Seeds of the following:

27850. DIOSPYROS sp. **"Mambolo."**

27851. GUSTAVIA sp.

27852. MIMUSOPS CORIACEA (DC.) Miq.

Distribution.—In woods on the islands of Madagascar and Mauritius.

27853 to 27855. MANGIFERA INDICA L. **Mango.**

27853. *Auguste.*

27854. *Cuiller.*

27855. *José.*

27856 to 27858. CITRULLUS VULGARIS Schrad. **Watermelon.**

From Roumania. Procured by Mr. Horace G. Knowles, formerly American consul at Bucharest, now American minister resident and consul general, Santo Domingo, Dominican Republic. Received February 25, 1910.

27856 to 27858—Continued.

Seeds of the following; notes taken from the sacks:

27856. "*Rattlesnake Junior.* Small, striped, oval; meat dark pink."

27857. "*Carmen Sylva.* Meat perfectly white."

27858. "*Princess Marie.* I am sure this is seed of the dark-green skin and dark-red meat variety, the kind most grown in Roumania."

27859 to 27872. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From Monetta, S. C. Grown by Mr. J. M. Johnson, crop of 1909. Numbered for convenience in recording distribution May 7, 1910.

Seeds of the following:

27859 to 27861. Hybrids between *Iron* and *Black.*

27859. (P. B. No. 14a4-1-3-1.)

27860. (P. B. No. 14a4-1-3-4.)

27861. (P. B. No. 14a8-5-3-1.)

27862 to 27866. Hybrids between *Iron* and *Large Blackeye.*

27862. (P. B. No. 17b2-2-1.)

27863. (P. B. No. 17b2-2-2.)

27864. (P. B. No. 17b2-2-3.)

27865. (P. B. No. 17b2-2-4.)

27866. (P. B. No. 17c2-2-2.)

27867 to 27871. Hybrids between *Iron* and *Whippoorwill.*

27867. (P. B. No. 18b1-2-3.)

27868. (P. B. No. 18b1-2-4.)

27869. (P. B. No. 18b5-1-1.)

27870. (P. B. No. 18b5-1-2.)

27871. (P. B. No. 18b9-1-1.)

27872. *Iron.*

27873. SAPIUM JENMANI Hemsl.

From Georgetown, Demarara, British Guiana. Presented by Mr. F. A. Stockdale, assistant director and Government botanist, Science and Agriculture Department, Botanic Gardens. Received May 5, 1910.

"A rubber-producing plant, that should be planted in a humid situation, shaded from the wind. It does best here in well-drained, fully cleared clayey-peaty land some distance up the rivers, and is making most excellent growth at our experiment stations. In heavy clay soils, exposed to wind, this plant does not grow luxuriantly, developing into a shrubby bush very liable to attacks from *Lecanium* scale." (*Stockdale.*)

"A tall forest tree growing in the low, warm forests of British Guiana and said to be the principal, if not the only, source of the rubber exported from that colony. This rubber has a wonderful elasticity and fetches the highest prices in the English markets. It is extracted as *scrap* by the native Indians. This tree might be grown with good results in the Philippine Islands." (*H. Pittier.*)

Distribution.—In the alluvial forests of the Pomeroon district of British Guiana.

27874. (Undetermined.)

From Horqueta, Paraguay, South America. Presented by Mr. T. R. Gwynn. Received May 6, 1910.

"*Ymangazu*, Paraguay rubber seed." (*Gwynn.*)

27875 and 27876. Triticum spp. **Wheat.**

From the plains of Thebes near the colossi of Memnon, Egypt. Presented by Mr. A. J. Perkins. Received April 29, 1910.

Seeds of the following:

27875. Small, dark kernels.

27876. Large, white kernels.

27877 to 27887.

From Malkapur, Berar, India. Presented by Mr. A. S. Dhavale, care of Mr. V. B. Savaji. Received April 30, 1910.

Seed of the following. Unless otherwise stated, notes by Mr. Dhavale.

27877 to 27879. Andropogon sorghum (L.) Brot. **Durra.**

"*Juar.* The chief food and fodder crop of this section."

27877. "One of the inferior kinds."

"A form of durra with obovate white seeds of medium size, about equaled by the transversely wrinkled glumes which are coriaceous and black at the base, greenish white and papery above the transverse shoulder." (*Carleton R. Ball.*)

27878. "The best and superior kind."

"A form of durra with rather large, broadly obovate or subrotund, pearly-yellow seeds which exceed the coriaceous, greenish-yellow glumes which are transversely wrinkled and often dark in color below the wrinkle." (*Carleton R. Ball.*)

27879. "One of the inferior kinds."

"Apparently similar to No. 27877, but the seeds are rather larger and the outer part of the glumes more coriaceous." (*Carleton R. Ball.*)

27880 and 27881. Crotalaria spp.

"*Bichawa.* A wild legume for green manuring."

27880. Crotalaria juncea L.

See No. 26356 for description.

27881. Crotalaria sp.

"The rare kind."

27882 and 27883. Dolichos lablab L. **Bonavist bean.**

27882. "*Val.* Blackish green, short pod. A garden vegetable crop, also used for green manure."

27883. "*Val.* White, short pod. A garden vegetable crop also used for green manure."

27884. Lathyrus sativus L.

"*Lakha.* A leguminous fodder and food crop."

27885. Pennisetum americanum (L.) Schum. **Pearl millet.**

"*Bajra.* The secondary food and fodder crop."

27886. Phaseolus aconitifolius Jacq.

"*Matha.* A leguminous fodder and food crop."

27887. Vigna sesquipedalis (L.) W. F. Wight.

"*Val.* White, long pod. A garden vegetable crop, also used for green manuring."

27903. SOLANUM ETUBEROSUM Lindl. (?)

From near the baths of Chillian, Chile, at an altitude of about 2,200 metres above sea level. Received through Mr. José D. Husbands, Limavida, Chile, May 2, 1910.

"A friend of mine procured these seeds from a plant which, he says, is very much like a potato. The tubers could not be obtained, as they were growing in the dirt, within the crevices of rocks, very deep down. This may possibly be *Solanum etuberosum*." (*Husbands.*)

27904 to 27924. CRYPTOCARYA RUBRA (Mol.) Skeels.

From central Chile. Received through Mr. José D. Husbands, Limavida, Chile, May 12, 1910.

"Seeds of different strains of this tree each showing some variation in fruit, leaf, growth, etc." (*Husbands.*)

Distribution.—Found in the woods and along streams, in the vicinity of Antuco, in central Chile.

See Nos. 23897 and 24310 for previous introductions.

27925. QUERCUS CORNEA Lour. **Oak.**

From Hongkong, China. Purchased from Mr. W. J. Tutcher, superintendent, Botanical and Forestry Department. Received at the Plant Introduction Garden, Chico, Cal., April, 1910.

See No. 10633 for description. (Seed.)

Distribution.—In the vicinity of Hongkong and Hainan in China, in the province of Tongking in Cochin China, and in the islands of Borneo and Java.

27926 to 27928. MANGIFERA INDICA L. **Mango.**

From Port Louis, Mauritius. Presented by Mr. G. Regnard. Received May 12, 1910.

Seed of the following:

27926. *Aristide.* "The best of our mangos." (*Regnard.*)

27927. *Baissac.*

27928. *Maison Rouge.*

27929. FLACOURTIA RAMONTCHI L'Herit.

From Port Louis, Mauritius. Presented by Mr. G. Regnard. Received May 12, 1910.

See No. 26655 for previous introduction. (Seeds.)

27930. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From Atlanta, Ga. Purchased from Messrs. H. G. Hastings & Co. Received May 11, 1910.

"*The Quick pea.*—This is strictly a new variety found by us in the hands of an Atlanta market gardener. We call it the Quick pea, because it is the quickest in market. It is of rather low, bushy growth, but every pod is ripened up above the foliage, long stems being thrown up. Every pod grows entirely in the sun. It makes quick, plenty of long, slender, meaty, fine-flavored pods for use as snaps, coming in before anything else. Three crops a year can be grown." (*Hastings's Catalogue No. 37, Spring, 1909.*)

27931. Alysicarpus vaginalis (L.) DC.

From Alabang Riyal, Philippine Islands. Presented by Mr. Le Roy J. Fattey at the request of Mr. J. B. Thompson, Special Agent in Charge, Agricultural Experiment Station, Island of Guam. Received May 6, 1910.

Known in the Philippine Islands as "*Manimanian.*"

See No. 26786 for description.

27932. Rheedia edulis (Seem.) Planch. & Triana. **Sastra.**

From Puerto Mutis, Republic of Panama. Presented by Mr. W. M. Morse, Boston Panama Company, at the request of Mr. H. F. Schultz. Received May 12, 1910.

See No. 27485 for description.

27933. Hordeum sp. **Barley.**

From Tiflis, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, April 28, 1910.

White seeded.

Note.—This was picked out of a lot of black-seeded barley received under Meyer No. 1301a (S. P. I. No. 27829). See this number for remarks.

27934. Gossypium sp. **Cotton.**

From Unsan, Korea. Presented by Mr. J. D. Hubbard. Received May 16, 1910.

"This seed was all grown north of the fortieth parallel, and is probably the hardiest cotton in existence. On favorable soil in Korea this plant grows waist high and has many pods; these are not gathered until the bush has been killed by frost in late October or November. This variety has undoubtedly gained in hardiness during the ages it has been planted by the northern Koreans. The main article of clothing among the Koreans is the cotton suit, made from this home product." (*Hubbard.*)

27935. Opuntia sp.

From Manila, Philippine Islands. Presented by Mr. W. S. Lyon. Received May 17, 1910.

"An absolutely spineless opuntia. I fancy it is not indigenous, because I have only found it about habitations. I will warrant it with never a rudimentary spine. It is a 'buster' for size, makes a woody caudex as thick as a man's thigh, grows 11 to 13 feet tall and of like diameter of crown. For such things as might eat it, it would, I should think, crop a modest 200 tons or so per acre." (*Lyon.*)

27936. Zea mays L. **Corn.**

From Guadalajara, Mexico. Procured by Hon. Samuel E. Magill, American consul. Received May 18, 1910.

Jala.

27937 to 27946. Zea mays L. **Corn.**

From Guerrero, Mexico. Procured by Mr. Marion Letcher, American consul at Acapulco, Mexico. Received May 16, 1910.

Seeds of the following; descriptive notes as given by Mr. Letcher:

27937. *Conejo Blanco.* "Average length of ears 5½ inches, average gross weight of ears 95 grams, average weight of cob 15 grams, net weight of corn on ear 80 grams. This corn is planted at the beginning of the rainy season for quick maturity. The crop can be gathered forty to fifty days after planting."

27937 to 27946—Continued.

27938. *Morado Breve.* Average length of ear 5 inches, average gross weight of ear 54 grams, average weight of cob 11 grams, average net weight of corn to ear 43 grams. As will be noted by the weights given above, the ears are very small. The grains are also very small and dark purple in color. It is planted as soon as the rains commence in June, and is gathered in forty or fifty days from time of planting."

27939. *Escorpioncillo.* "Average weight per ear, gross, 125 grams, average weight of cob 20 grams, average net weight of corn to ear 105 grams, average length of ear 7 inches. This is also an early maturing variety, but requires about ten days more than the two preceding."

27940. *Zapalote morado* or *Bandeno.* "Average length of ear 7½ inches, average gross weight 190 grams, average weight of cob 33 grams, average net weight of corn to ear 157 grams. Matures about seventy days after planting. Makes a fine forage crop because of the number and size of blades."

27941. *Zapalote Blanco.* "Average length per ear 7 inches, average gross weight 170 grams, average weight of cob 29 grams, average net weight of corn to ear 141 grams. Same as the preceding except that it has somewhat smaller ears and fewer blades."

27942. *Olote Colorado.* "Average length of ear 6½ inches, average gross weight of corn 148 grams, average weight of cob 30 grams, average net weight of corn to ear 118 grams. The term 'Colorado' (red) refers to the color of the cob. This variety matures in eighty days after planting."

27943. *Olotillo.* "Average length of ear 6 inches, average gross weight of ear 110 grams, average weight of cob 15 grams, average net weight of corn to ear 95 grams. Matures in ninety days."

27944. *Maizon.* "Average length of ear 7½ inches, average gross weight of ear 150 grams, average weight of cob 24 grams, average net weight of corn to ear 126 grams. Matures in ninety days. Resembles the preceding but give a stronger and heavier plant. Yield per plant larger than any other plant described."

The preceding numbers were grown on the "La Luz" hacienda, of which Uruñuela Hermanos of this place are the proprietors.

27945. *Magueyano.*

27946. *Laguneno.*

"These two varieties were presented by Mr. Carlos Miller, Cuajiniquilapa, Guerrero, but without any descriptive notes. Mr. Miller is one of the most progressive farmers of the State, and the two samples submitted doubtless represent the best varieties planted on his lands."

27949. POLYGONUM TINCTORIUM Lour.

From Yokohama, Japan. Purchased from Yokohama Nursery Company. Received May 16, 1910.

"Introduced for trial as a nectar-producing crop to be grown on waste lands, in cooperation with the Bureau of Entomology, also for testing as a tannin plant." (*R. A. Young.*)

Distribution.—The provinces of Shingking, Szechwan, and Kwangtung, in the Chinese Empire; near Seoul in Korea, and commonly cultivated in Japan.

27950. Sapindus saponaria L.

From Vera Cruz, Mexico. Presented by Mr. William W. Canada, American consul at Vera Cruz. Received May 19, 1910.

"This berry-like fruit grows in clusters like the grape, and a tree will have at one time as many as one hundred of these clusters. The tree generally attains a height of from 10 to 15 feet and is very leafy and spreading. They abound in the vicinity of Vera Cruz, where the fruit is known by the name of '*Jaboncillo*.'

"The remarkable saponaceous properties of the fruit would warrant one to believe that it may possess a commercial value. If one of the berries be cut open by passing a sharp knife around its middle, a black, hard seed will drop therefrom, and the pulp and shell are the parts that appear to contain the soapy properties. When rubbed upon a wet hand, a good cleansing lather is immediately formed, one that to all appearances has been produced by ordinary soap." (*Canada.*)

27951. Vaccinium vitis-idaea minor Lodd. **Mountain cranberry.**

From Charlottetown, Prince Edward Island, Canada. Procured through Mr. Frank Deedmeyer, American consul. Received May 19, 1910.

See No. 26420 for previous introduction.

27952 to 27954.

From Honolulu, Hawaii. Procured by Mr. J. E. Higgins, horticulturist, Agricultural Experiment Station. Received May 18, 1910.

27952 and 27953. Vaccinium reticulatum Smith. **Ohelo.**

27952. (Root cuttings.) **27953.** (Seeds.)

"A shrub closely related to the blueberries of the eastern United States, but bearing a larger berry of a light-red color. The fruit is described as edible, though somewhat astringent. Preserves and jelly are made from it. The plant is celebrated in the native song and ceremonial of Hawaii because of the beauty of its berries and the occurrence of the bush on high mountain summits. These roots and seeds have been imported for use in experiments on the domestication of the blueberry." (*Frederick V. Coville.*)

Distribution.—In woods on the upper slopes of the mountains in the Hawaiian Islands.

27954. Claucena lansium (Lour.) Skeels.

"The trees which I have seen in Hawaii are about 18 to 20 feet high and bear quite freely, their fruits are about the size of a cherry, and straw yellow in color, very much like the longan. The fruit is very highly prized by the Chinese." (*Higgins.*)

See No. 25546 for previous introduction.

27955. Euphorbia resinifera Berg.

From Algiers, Algeria. Presented by Dr. L. Trabut. Received May 23, 1910.

"This is a cactuslike plant of the mountainous parts of Morocco, furnishing the gum resin known to the crude drug market as euphorbium. In the month of September, after the rains have set in, the plant becomes very full of a milky sap contained in numerous unbranched latex tubes. The plants are slashed with cutting apparatus, and the milky juice, exuding in quantity, dries on the surface of the plant in irregular masses. These are torn off by the natives and shipped to commercial centers from the ports of Morocco. Owing to the irritating character of the material,

27955—Continued.

the natives protect the mouth and nose with cloths while working on this product." (*R. H. True.*)

Distribution.—The lower slopes of the Atlas Mountains in Morocco.

27956. GOSSYPIUM BARBADENSE L. **Cotton.**

From Trujillo, Honduras. Presented by Mr. T. S. Chaffee, through Dr. J. N. Rose, Associate Curator, Division of Plants, U. S. National Museum, Washington, D. C. Received May 23, 1910.

"A sample of sea island cotton grown here from seed planted the latter part of August, 1909. The stalk measured 10½ feet in height and bore 78 bolls and 6 blossoms." (*Chaffee.*)

27957. FEIJOA SELLOWIANA Berg. **"Guayuba."**

From Salto, Uruguay. Presented by Mr. John J. C. Williams. Received May 23, 1910.

For description see S. P. I. Nos. 26120 and 26121.

27958. ROYENA PALLENS Thunb.

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, Government agrostologist and botanist. Received May 23, 1910.

"*Blaauw-bosch.* A bush growing in the semitropical and southwestern districts of the Transvaal, the fruit of which is said to be edible." (*Davy.*)

Distribution.—Along the margins of the woods in southern Africa, extending from Lower Guinea and the Mozambique district southward to the Cape, rising to an elevation of 5,000 feet in Natal.

27959. CACARA EROSA (L.) Kuntze.

From Tampico, Mexico. Presented by Dr. Edward Palmer. Received May, 1910.

"*Jicama de Aqua.* This is the finest and most valued variety, because of the agreeable water it affords. Travelers carry a supply of the roots as a substitute for water. This winter it was for sale at many street corners." (*Palmer.*)

See No. 22971 for previous introduction.

27960. CANNABIS SATIVA L. **Hemp.**

From Gumma Prefecture, Japan. Purchased from the Yokohama Nursery Company, Yokohama, Japan. Received May 21, 1910.

A large variety of hemp, said to be 10 feet long.

27961 to 27968.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, May 18, 1910.

Cuttings of the following:

27961. PUNICA GRANATUM L. **Pomegranate.**

From near Yelisavetpol, Caucasus, Russia. "(No. 753, Apr. 6, 1910.) A variety of pomegranate called in the Tartar language '*Kizil Kabuch.*' Fruits very large, sometimes 5 inches in diameter, of bright-red color; flesh of sour-sweet taste. Ripens in October and keeps for about four months. Obtained from the Vohrer Estate, Karaji.

"Yelisavetpol is famous for its pomegranates, which are said to be of finer quality than any place else in the Caucasus." (*Meyer.*)

27961 to 27968—Continued.

27962. Punica granatum L. **Pomegranate.**

From near Yelisavetpol, Caucasus, Russia. "(No. 754, Apr. 7, 1910.) The wild pomegranate which grows everywhere in the eastern part of the Caucasus and stands drought, heat, sterility of soil, etc., to a remarkable degree. The fruits are small and sour, but their juice can be used as a digestive seasoning with meats and game. Recommended as a hedge plant in mild-wintered, semiarid regions." (*Meyer.*)

27963. Vitis vinifera L. **Grape.**

From Yelisavetpol, Caucasus, Russia. "(No. 761, Apr. 5, 1910.) A tall grape of local origin, called '*Tavrish*' (synonyms *Handja Gandja* and *Blanc de Gangin*). Bunch medium large; berries round, medium size, of a pale-yellow color, very sweet; skin slightly hard. A very good shipper and keeper, being seen on the market until early summer." (*Meyer.*)

27964. Vitis vinifera L. **Grape.**

From Yelisavetpol, Caucasus, Russia. "No. 762, Apr. 5, 1910.) A native Caucasian grape called '*Achshira*' (Tartar), passing, however, with the German settlers in the Caucasus under the name of '*Ronde Weisse.*' Bunches medium large; berries medium size, round, white in color. Phenomenally productive. Gives a light white wine of good quality. Very much planted in this vicinity, seeming to prefer a rather heavy soil." (*Meyer.*)

27965. Punica granatum L. **Pomegranate.**

From Geok-Tepe, Caucasus, Russia. "(No. 765, Apr. 12, 1910.) A pomegranate of apparently local distribution, called '*Valas.*' Fruits very large, of rosy-red color, very juicy and of sour-sweet taste. Considered a very fine variety. Obtained from Mr. A. Shelkovnikoff." (*Meyer.*)

27966. Punica granatum L. **Pomegranate.**

From Geok-Tepe, Caucasus, Russia. "(No. 766, Apr. 12, 1910.) A pomegranate called '*Kyrmisi Kabugh.*' Fruits large, bright red, of sour-sweet taste. Obtained from Mr. A. Shelkovnikoff. Perhaps the same as No. 707 (S. P. I. No. 27773)." (*Meyer.*)

27967. Punica granatum L. **Pomegranate.**

From Geok-Tepe, Caucasus, Russia. "(No. 767, Apr. 12, 1910.) A pomegranate called '*Shirin nar.*' For description see No. 706 (S. P. I. No. 27772), which is the same. Obtained from Mr. A. Shelkovnikoff." (*Meyer.*)

27968. Malus pumila Miller. **Paradise apple.**

From Geok-Tepe, Caucasus, Russia. "(No. 768, Apr. 11, 1910.) A bushy apple, apparently rarely growing over 5 feet in height. A native of the Caucasus, from whence it was probably introduced into western Europe, where it is now so extensively used as a dwarfing stock for apples. This shrubby apple produces red fruits of fair quality, is very drought resistant, and stands high summer temperatures. May be used in hybridization work and in creating a strain of bush apples." (*Meyer.*)

Distribution.—Cultivated and naturalized in central and eastern Europe and in western Asia.

27969. Sicana odorifera (Vell.) Naud. **Cassabanana.**

From Guatemala. Presented by Capt. A. F. Lucas. Received May 21, 1910.

27969—Continued.

See No. 11720 for previous introduction.

Distribution.—From southern Mexico and Guatemala southeastward to the province of Sao Paulo in Brazil, and in the West Indies.

27970 to 27977.

From Cambridge, England. Presented by the Director of the Botanic Gardens, Cambridge University. Received April 22, 1910.

Seed of the following:

27970. CHAETOCHLOA MACROSTACHYA (H. B. K.) Scribn. & Merrill.

Distribution.—In dry soil from Texas southward through Mexico and Central America to Brazil.

27971. CHAETOCHLOA sp.

27972. MELILOTUS DENTATA (W. & K.) Pers.

27973. MELILOTUS INDICA (L.) All.

27974 to 27976. PISUM ARVENSE L. **Pea.**

27977. PISUM SATIVUM UMBELLATUM L.

27978. STIZOLOBIUM sp.

From Tamsui, Formosa. Presented by Mr. Samuel C. Reat, American consul. Received May 24, 1910.

27979. MEDICAGO SATIVA L. **Alfalfa.**

From between Dushet and Passanaura, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, May 20, 1910.

"(No. 1333a, Apr. 30, 1910.) A small-leaved variety growing in stony débris that has been washed from the mountain sides. Found at an elevation of between 4,000 and 5,000 feet above sea level. Roots sent under No. 777 (S. P. I. No. 28043); see this number for further description." (*Meyer.*)

27980 to 27995.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, May 21, 1910.

Seeds of the following:

27980. MEDICAGO SATIVA L. **Alfalfa.**

From Erivan, Caucasus, Russia. "(No. 1315a, Mar. 28, 1910.) An alfalfa, passing locally under the Tartar name '*Yondjin.*' This lot is supposed to be a more drought-resistant strain than No. 1304a (S. P. I. No. 27803), but as statements from native dealers can not be depended on, it may not be so. In Yelisavetpol I was informed that Erivan alfalfa lasts ten years, while Turkestan alfalfa lasts only six. In case this should be so it makes this a much more valuable forage plant than the central Asian strains. See also remarks under No. 1304a (S. P. I. No. 27803), which is probably the same." (*Meyer.*)

27981. MEDICAGO SATIVA L. **Alfalfa.**

From near Yelisavetpol, Caucasus, Russia. "(No. 1316a, Apr. 8, 1910.) An alfalfa found along the banks of a dry river bed. Roots sent under No. 763." (*Meyer.*)

27980 to 27995—Continued.

27982. MEDICAGO SATIVA L. **Alfalfa.**

From near Yelisavetpol, Caucasus, Russia. "(No. 1317a, April 7, 1910.) An alfalfa found wild on the brinks of ravines, in open plains, and along roads. Grows on rather heavy clayey soil. Roots sent under No. 756." (*Meyer.*)

27983. VICIA FABA L. **Broad bean.**

From Yelisavetpol, Caucasus, Russia. "(No. 1318a, April 7, 1910.) A small variety of broad bean, grown as a garden vegetable by the Persian population." (*Meyer.*)

27984. PHASEOLUS VULGARIS L. **Bean.**

From Yelisavetpol, Caucasus, Russia. "(No. 1319a, April 7, 1910.) A local variety of running garden bean, called '*Kolo-lobia.*' Considered locally one of the finest beans grown for culinary purposes. Can be eaten green as well as dried. To be tested under irrigation in the hot-summered, arid, and semiarid sections of the United States." (*Meyer.*)

27985. PHASEOLUS VULGARIS L. **Bean.**

From Geok-Tepe, Caucasus, Russia. "(No. 1320a, April 12, 1910.) An improved variety of the preceding number, called '*Kolo-lobia.*' Came originally from the Nuga district, Caucasus. Considered even by the Russians a very fine bean for the table. Obtained from Mr. J. K. Dieterichs. To be tested in regions like No. 1319a (S. P. I. No. 27984)." (*Meyer.*)

27986. CITRULLUS VULGARIS Schrad. **Watermelon.**

From Yelisavetpol, Caucasus, Russia. "(No. 1321a, April 7, 1910.) A red-fleshed variety, said to grow large and to be of very fine quality. To be tested in regions like No. 1319a (S. P. I. No. 27984)." (*Meyer.*)

27987. CITRULLUS VULGARIS Schrad. **Watermelon.**

From Yelisavetpol, Caucasus, Russia. "(No. 1322a, April 7, 1910.) Mixed varieties of watermelons. The small seeds are said to produce fruits weighing up to 30 pounds, and when being eaten the seeds in these are scarcely noticeable. The Yelisavetpol watermelons are noted for their large size and good quality. To be tested in regions like No. 1319a (S. P. I. No. 27984)." (*Meyer.*)

27988. CUCUMIS MELO L. **Muskmelon.**

From Geok-Tepe, Caucasus, Russia. "(No. 1323a, April 12, 1910.) A variety of muskmelon, called '*Dootma.*' Comes from the Erivan district, seeds sent from this locality under No. 1306a (S. P. I. No. 27805). Obtained from Mr. Dieterichs. To be tested like No. 1319a (S. P. I. No. 27984). These melons are buried underneath the soil while growing, as otherwise they do not acquire the right flavor and aroma." (*Meyer.*)

27989. CUCUMIS MELO L. **Muskmelon.**

From Yelisavetpol, Caucasus, Russia. "(No. 1324a, April 7, 1910.) A local variety of muskmelon, said to be large and of fine quality. To be tested like No. 1319a (S. P. I. No. 27984)." (*Meyer.*)

27990. CUCUMIS MELO L. **Muskmelon.**

From Yelisavetpol, Caucasus, Russia. "(No. 1325a, April 7, 1910.) A choice local variety of muskmelon. Said to be of very fine texture and flavor. To be tested like No. 1319a (S. P. I. No. 27984)." (*Meyer.*)

27991. CUCUMIS MELO L. **Muskmelon.**

From Geok-Tepe, Caucasus, Russia. "(No. 1326a, April 12, 1910.) A strictly local variety of muskmelon, called '*Germek.*' Of extra fine quality,

27980 to 27995—Continued.

large size, almost globular in shape, color pale yellow with green stripes; very early, no shipper. Obtained from Mr. J. K. Dieterichs, who recommends this melon for trial in hotbeds." (*Meyer.*)

27992. CUCUMIS SATIVUS L. **Cucumber.**

From Geok-Tepe, Caucasus, Russia. "(No. 1327a, April 12, 1910.) A very fine local variety of cucumber, green, medium large, and very tender. Obtained from Mr. J. K. Dieterichs. To be tested like No. 1319a (S. P. I. No. 27984)." (*Meyer.*)

27993. PISTACIA VERA L. **Pistache.**

From Yelisavetpol, Caucasus, Russia. "(No. 1328a, April 7, 1910.) Pistachio nuts bought on the market in Yelisavetpol, said to come from Persia. Not of very fine flavor." (*Meyer.*)

27994. PANICUM MILIACEUM L. **Proso millet.**

From Erivan, Caucasus, Russia. "(No. 1329a, March 28, 1910.) A local variety of proso having large, brownish-red seeds. Said to be drought resistant." (*Meyer.*)

27995. TRITICUM AESTIVUM L. **Wheat.**

From Erivan, Caucasus, Russia. "(No. 1330a, March 28, 1910.) A local variety of soft, white, winter wheat. To be tested under irrigation in mild-wintered climates." (*Meyer.*)

27996 to 28015.

From Peru, South America. Presented by Prof. William Curtis Farabee, Division of Anthropology, Harvard University, Cambridge, Mass. Received May 2, 1910.

Seeds of the following; notes taken from the packets:

27996. AMARANTUS sp.

From Amazon River. A plant with red leaves, eaten by cattle.

27997. CAJAN INDICUM Spreng.

Grows and produces all year.

27998. CANAVALI ENSIFORME (L.) DC.

From Madre de Dios River, altitude 900 feet.

27999. CUCURBITA FICIFOLIA Bouche.

From near Cuzco, altitude 10,000 feet.

Distribution.—Cultivated generally in the Tropics; said by some authors to be native in eastern Asia, but probably native in Peru, although nothing definite can be stated as to its native region.

28000. CUCURBITA PEPO L.

From Urubamba River. A pumpkin or squash, round, small, very good to bake.

28001. CUCURBITA sp.

From Cuzco. Very sweet.

28002. GOSSYPIUM PERUVIANUM Cav.

From upper Ucayali River.

Distribution.—Peru, Chile, and Ecuador; cultivated generally in cotton-producing countries.

27996 to 28015—Continued.

28003. Gossypium sp. **Kidney cotton.**

From Madre de Dios River.

28004. Hordeum vulgare L. **Barley.**

From Cuzco Valley.

28005. Lagenaria vulgaris Ser.

From Urubamba River.

28006 to 28008. Lycopersicon sp.

28006. From Urubamba Valley.

28007. From Urubamba Valley.

28008. From St. Ana on Urubamba River.

Grow the size of a cherry.

28009. Medicago hispida confinis (Koch) Burnat.

28010. Passiflora sp.

From Mishajua (?) River. Small pomegranate-like fruits that grow on a vine. Very good.

28011. Rubus sp. **Wild raspberry.**

Growing at an elevation of 11,000 feet, 13° S. lat. Red, much larger than the common sort, good flavor, but sour.

28012. Sicana odorifera (Vell.) Naud. **Cassabanana.**

From Urubamba River. Seed from a red gourd or pumpkin, grows on a vine which makes good shade. The fruits are good to eat and have a very pleasant odor when taken off the vine, left in the sun a short time, and then brought into the house for a few days.

See No. 27969 for previous introduction.

28013. Triticum sp. **Wheat.**

From Cuzco Valley.

28014. Vigna unguiculata (L.) Walp. **Cowpea.**

From Urubamba River. A small white bean which grows on the sandy banks and needs hot sun. Contains a great deal of oil.

28015. Zea mays L. **Corn.**

From Cuzco Valley. Large, white seeded.

28016. Protea mellifera Thunb.

From Cape Town, South Africa. Presented by the Conservator of Forests, at the request of Prof. J. Burtt Davy, agrostologist and botanist, Transvaal Department of Agriculture. Received May 28, 1910.

A South-African bush, useful both as an ornamental and as a bee plant.

See No. 26207 for previous introduction.

28017. Chenopodium quinoa Willd. **Quinoa.**

From Bolivia, South America. Presented by Señor Don Ygnacio Calderón, E. E. and M. P., Bolivian Legation, Washington, D. C. Received May 24, 1910.

"This grain is very nutritious, the plant grows well in high altitudes, and requires little moisture." (*W. A. Reid, of the Legation.*)

Distribution.—Cultivated in Colombia, Peru, and Chile; probably native in the same region.

See Nos. 18536 and 18537 for further description.

28022 and 28023.

From Tiflis, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, May 12, 1910.

Seeds of the following:

28022. Prunus sp. **Bush cherry.**

"(No. 1331a, Apr. 25, 1910.) A low-growing bush cherry found on very dry and stony places here and there in the Caucasus. Produces a multitude of small, rosy flowers in early April. The fruits are small and sour and can be used for compotes and jellies. Recommended as a stock for various stone fruits in arid and semiarid regions and for hybridizing purposes to create large-fruited, bushy forms of cherries. Obtained from the Tiflis Botanical Garden." (*Meyer.*)

28023. Anchusa myosotidiflora Lehm.

"(No. 1332a, Apr. 25, 1910.) A beautiful, perennial, spring-flowering plant, looks strikingly like a large forget-me-not. Prefers shady places. Recommended as a garden ornamental on shady situations in semiarid, mild-wintered regions. Obtained from the Tiflis Botanical Gardens." (*Meyer.*)

Distribution.—Shady banks and cliffs in the Caucasus region, and in the Altai Mountains of southern Siberia.

28024 to 28029.

From Tsungming, China. Obtained by Rev. James Ware of the Foreign Christian Missionary Society, Shanghai, China, and forwarded through Mr. Amos P. Wilder, American consul general. Received May 20, 1910.

"Tsungming is an alluvial island in the estuary of the Yangtze River. It lies between 31° and 32° north latitude. Prevailing winds from southeast. Total length from east to west 60 miles, average breadth 12 miles. The soil is rich except in the northwest corner, where it is overcharged with alkali. Population, including small islands around, and a few towns on the north mainland, 1,200,000." (*Ware.*)

Seeds of the following:

28024 to 28027. Andropogon sorghum (L.) Brot.

28024. "*Premier.* This sorghum seed is from the middle of the island. It develops 13 joints in the stem, hence it bears the name '*13-jointed*' sorghum. It is the fullest and most productive of island sorgos." (*Ware.*)

"*Chinese* sorgo. A sorgo with obovate spikelets; black glumes with compressed tips; very small seeds and short awns. Probably the same as the Chinese sorgo originally introduced from the Island of Tsungming to France in 1851, and to the United States in 1853. Apparently identical with S. P. I. No. 22913." (*Carleton R. Ball.*)

28025. "The '*Tender*' sorghum is greatly cultivated, as it seems to be the easiest raised. It grows to a height of about 5 feet." (*Ware.*)

"Sorgo very similar to the preceding number, but with glumes varying from the normal greenish yellow to a light brown." (*Carleton R. Ball.*)

28026. "The '*Hard*' sorghum is planted about three weeks before the tender, and is cut about two weeks later. It is largely grown and reaches a height of about 4 feet." (*Ware.*)

"Appears to be a mixture of the two preceding numbers, some glumes being black and some being brown." (*Carleton R. Ball.*)

28024 to 28029—Continued.

28027. "Kowliang. Said to be the finest variety on the island." (*Ware.*)

"Brown Kowliang. Apparently the same as S. P. I. No. 22911." (*Carleton R. Ball.*)

"Please note that although sorgo is cultivated on an extensive scale the Chinese have never used the stalk for sirup manufacture. It is sold on the markets in bundles and chewed for the juice, and also fed to the pigs." (*Ware.*)

28028. Panicum miliaceum L. **Proso millet.**

"Mixed millet. This is mixed ready for sowing. Unless mixed, each variety would be too hard for domestic use, but in growing a mixed crop, one kind is fructified by the other and a grain is produced which is much valued as an article of diet. In many places it is ground and takes the place of flour." (*Ware.*)

28029. Chaetochloa italica (L.) Scribn.

"Yellow. Also highly valued and used as the preceding (S. P. I. No. 28028)." (*Ware.*)

28030. Rosa gigantea Collett.

From Santa Barbara, Cal. Purchased from Dr. F. Franceschi. Received at the Plant Introduction Garden, Chico, Cal., May 12, 1910.

For previous introduction of this species, see No. 27301.

28031 to 28033. Dolichos spp.

From Poona, Bombay, India. Procured from Mr. T. F. Main, deputy director of agriculture. Received May 23, 1910.

Seeds of the following:

28031. Dolichos biflorus L.

"*Kulthi.*"

28032 and 28033. Dolichos lablab L. **Bonavist bean.**

28032. "*Kadra Wal.*" **28033.** "*Local Wal.*"

28034. Pinus gerardiana Wall.

From Fort Sandeman, Baluchistan. Purchased from Col. G. C. Trench, political agent in Zhob. Received May 23, 1910.

See Nos. 21819 and 25316 for description. (Seeds.)

28035. Phaseolus aconitifolius Jacq.

From Poona, Bombay, India. Purchased from Mr. T. F. Main, deputy director of agriculture. Received May 23, 1910.

"*Math.*" (Seeds.)

28036 and 28037.

From Russia. Purchased from Messrs. Vollmer & Co., Riga, Russia. Received May 31, 1910.

Seeds of the following:

28036. Trifolium pratense L. **Red clover.**

Orel.

28036 and 28037—Continued.

28037. MEDICAGO SATIVA L. Alfalfa.

Samara. "This lucern seed has been grown in one of the coldest Governments in Russia, and has been recognized to be the hardiest strain ever offered. No other lucern seed will compare with it, as it comes from the cold Samara Government, near the Ural." (*Vollmer.*)

28038. ANDROPOGON SORGHUM (L.) Brot. **Sorgo.**

From Chekiang Province, China. Secured by Rev. James Ware, of the Foreign Christian Missionary Society, Shanghai, China, and forwarded through Mr. Amos P. Wilder, American consul general. Received May 20, 1910.

"This sorgo is said to grow very high. It is sown from the middle to the end of May." (*Ware.*)

"This is a sorgo very similar to No. 28024 from Tsungming Island. The spikelets are heavier and the seeds much larger, which may be due, however, to difference in cultivation. All the specimens from Tsungming Island are poorly developed, the percentage of fertile seed being small." (*Carleton R. Ball.*)

28039 to 28047.

From Russia. Received through Mr. Frank N. Meyer, agricultural explorer, May 23, 1910.

Plants of the following:

28039. MEDICAGO sp.

From near Mshet, Caucasus, Russia. "(No. 772, April 29, 1910.) A perennial Medicago of rather vigorous growth, found on dry limestone banks at elevations of 3,000 feet above sea level. This and the following numbers of Medicagos and Trifoliums should be valuable as fodder plants in the cooler sections of the United States." (*Meyer.*)

28040. MEDICAGO sp.

From near Dushet, Caucasus, Russia. "(No. 773, April 29, 1910.) A perennial, large-leaved Medicago, found on dry places between rocks at elevations from 3,000 to 4,000 feet." (*Meyer.*)

28041. MEDICAGO FALCATA L. (?)

From between Dushet and Passanaura, Caucasus, Russia. "(No. 775, April 30, 1910.) A perennial, small-leaved Medicago, found in stiff clay banks at elevations over 4,000 feet." (*Meyer.*)

28042. MEDICAGO sp.

From between Dushet and Passanaura, Caucasus, Russia. "(No. 776, April 30, 1910.) A perennial, large-leaved Medicago, growing between rocks and stones at elevations of about 4,000 feet." (*Meyer.*)

28043. MEDICAGO sp.

From between Dushet and Passanaura, Caucasus, Russia. "(No. 777, April 30, 1910.) A small-leaved, perennial Medicago of very compact growth, found in stony débris at the foot of mountains and cliffs at elevations between 4,000 and 5,000 feet. Apparently seeks moisture-retaining locations." (*Meyer.*)

28044.

From between Dushet and Passanaura, Caucasus, Russia. "(No. 778, April 30, 1910.) Trifolium and other Leguminosæ found on stony places at elevations over 4,000 feet." (*Meyer.*)

28039 to 28047—Continued.

28045. TRIFOLIUM sp.

From near Guda-ur, Caucasus, Russia. "(No. 779, May 1, 1910.) A perennial clover found on dry mountain slopes at elevations of about 7,000 feet. Very drought resistant and apparently able to stand severe cold." (*Meyer.*)

28046. MEDICÀGO SATIVA GLUTINOSA (Bieb.) Urban.

From near Vladikavkas, Caucasus, Russia. "(No. 781, May 3, 1910.) A large-leaved, perennial Medicago, found in dry, pebbly, limestone cliffs at about 3,000 feet elevation. Apparently very drought and cold resistant." (*Meyer.*)

28047. ASPARAGUS sp.

From near Dushet, Caucasus, Russia. "(No. 782, April 30, 1910.) An asparagus of ornamental habits, seen only once on a dry mountain side at an elevation of about 3,000 feet. Suitable for cultivation as a garden perennial, especially in regions of a light annual rainfall." (*Meyer.*)

28048 to 28058.

From Manchuria. Procured by Mr. Edward C. Parker, agriculturist, Bureau of Agriculture, Industry and Commerce, Mukden, Manchuria. Received June 2, 1910.

Seeds of the following; descriptive notes by Mr. Parker:

28048. CHAETOCHLOA ITALICA (L.) Scribn.

"*Small millet.* Chinese name, *Hsiaome.* This species of millet is grown everywhere in Manchuria, from Dairen to the Amur River, and from the Pacific Ocean on the east to Mongolia on the west. This sample comes from Mukden, Manchuria, 42° north latitude. It is one of the staple and universally used human foods in Manchuria. When properly hulled and cooked it is a delicious breakfast food."

28049 to 28051. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

28049. Large yellow. "*White Eyebrow* soy bean. Chinese name, *Paimei.* A well-known and famous variety of the soy bean grown over large areas on the alluvial bottom lands of the Liao Ho River in Manchuria. This seed sample came from valley lands near Kwangning, 42° north latitude, where the variety has been commonly grown for several centuries. Valuable in America as foundation stock for selecting and breeding improved varieties of oil-producing seeds."

28050. Small yellow. "Small, round soy bean. Chinese name, *Chinyuan.* This variety is grown in Manchuria as far north as 47° north latitude. This seed sample came from a district northeast of Harbin, Manchuria, 46° north latitude. The beans of this variety, grown in northern latitude, are highly prized because of their heavy weight and large per cent of oil. This variety should be especially valuable to plant breeders in the upper Mississippi Valley."

28051. Black. "Black curd bean. Chinese name, *Heitou.* Commonly grown in central Manchuria. This seed sample comes from Mukden, Manchuria, 42° north latitude. These beans are principally used for the production of bean curd. The beans are soaked, ground into coarse meal, and a filtrate formed that is coagulated with salt. The coagulated mass is pressed into a curd with stones. A meal made from these beans is mixed with corn meal for baking cakes."

28048 to 28058—Continued.

28052. Phaseolus angularis (Willd.) W. F. Wight. **Adzuki bean.**

"Red bean. Chinese name, *Hungchiangtou*. Commonly grown in central Manchuria for human food. This seed sample comes from Mukden, Manchuria, 42° north latitude. The beans are sometimes cooked green, but more commonly dried and boiled with millet or kowliang."

28053. Phaseolus radiatus L.

"Small green bean. Chinese name *Lutou*. Commonly grown in central Manchuria for human food. This sample comes from Mukden, Manchuria, 42° north latitude. These beans are usually cooked with millet or kowliang for food. They are also ground into meal and the meal mixed with kowliang meal in the production of vermicelli."

28054. Cannabis sativa L. **Hemp.**

"Chinese name *Howma*. Grown in large quantities in Manchuria for the production of fiber. This sample comes from Mukden, Manchuria, 42° north latitude."

28055. Fagopyrum vulgare Hill. **Buckwheat.**

"Chinese name *Chiaomai*. Common throughout all Manchuria, where it is sown in the latter part of June, or the first part of July, following barley or wheat. This sample comes from Mukden, Manchuria, 42° north latitude. Manchurian buckwheat, as a rule, appears to have larger and heavier kernels than varieties common in America."

28056. Oryza sativa L. **Rice.**

"Upland rice. Chinese name *Tschingtze*. Common in north central Manchuria. This sample comes from Mukden, Manchuria, 42° north latitude."

28057 and 28058. Andropogon sorghum (L.) Brot. **Kowliang.**

28057. "High stalk, spreading panicle. Chinese name *Sungma Kaoliang*. This plant is the chief and characteristic crop of Manchuria. Its seeds are the every day food of most of the common people, as well as the chief food of the farm animals. The leaves are stripped off the plant for live-stock food, and the stalks are burned to boil the water and heat the mud houses for all Manchuria. This sample of seed comes from Mukden, Manchuria, 42° north latitude, and is of a tall-growing variety with open or spreading panicle. This tall kowliang thrives best in latitude 38° to 42° north, maturing usually in October and requiring a late autumn to ripen properly. It will withstand drought, hot, drying winds, and an excess of moisture better than maize. The stalks are fibrous and rigid and do not lodge under stress as easily as maize."

"Seeds large, yellowish brown; glumes, light brown; contains a slight mixture of a black-glume variety." (*Carleton R. Ball.*)

28058. "Short stalk, compact panicle. Chinese name *Chinma Kaoliang*. This species matures somewhat earlier than the tall variety (S. P. I. No. 28057) and is grown commonly in Manchuria north of 42° north latitude. This sample comes from Mukden, Manchuria. Usage same as No. 28057."

"Seeds large, pale brown to reddish brown; glumes black and shining." (*Carleton R. Ball.*)

28059 and 28060.

From Saigon, Cochin China. Presented by Mr. P. Morange, Chef du Service de l'Agriculture. Received June 1, 1910.

Seed of the following:

28059. Diospyros decandra Lour.

Distribution.—The northern provinces of Cochin China; fruits offered for sale in the markets of the villages.

28060. Garcinia cochinchinensis (Lour.) Chois.

Distribution.—Cultivated and probably also native in Cochin China.

See No. 12021 for description.

28061. Britoa acida (Mart.) Berg.

From Para, Brazil. Presented by Mr. W. Fischer, Campo de Cultura Experimental Paraense. Received June 4, 1910.

"This plant is related to the guava; the fruit is round, with a diameter of 2 to 2½ inches; the taste is almost like that of the guava, but very acid. The seeds are few. The color is like the guava externally; internally it is pale yellow. The skin is thin." (*Fischer.*)

Distribution.—In the woods along the Amazon River in the vicinity of Nogueira, Brazil.

28062 and 28063. Medicago spp.

From Palermo, Sicily, Italy. Presented by the Director, Palermo Botanical Garden. Received May 6, 1910.

Seed of the following:

28062. Medicago hispida confinis (Koch) Burnat.

28063. Medicago hispida nigra (L.) Burnat.

28064 to 28069. Medicago spp.

From Madrid, Spain. Presented by the Director, Madrid Botanical Garden. Received May 6, 1910.

Seed of the following:

28064. Medicago blancheana Boiss.

Distribution.—Syria, extending from Marash southward to the region around Saida.

28065. Medicago hispida denticulata (Willd.) Urban.

28066. Medicago hispida Gaertn.

28067 and 28068. Medicago hispida nigra (L.) Burnat.

28069. Medicago rigidula (L.) Desr.

28070 and 28071. Medicago falcata L.

From Russia. Received through Prof. N. E. Hansen, Agricultural Experiment Station, Brookings, S. Dak., May 7, 1910.

Seeds of the following:

28070. "(No. 260.) Seeds gathered from plants growing wild in the dry steppes of the Semipalatinsk region, Akmolinsk Province, southwestern Siberia, in 1908, by courtesy of Mr. L. A. Sladkoff, assistant director, Department of Crown Domains, Omsk, Siberia." (*Hansen.*)

28070 and 28071—Continued.

28071. "(No. 261.) Seeds gathered from plants growing wild in the dry steppe region at Orenburg in 1908, by courtesy of Mr. W. S. Bogdan, agronomist of the Turgai-Ural region, Orenburg, Orenburg Province, on the extreme eastern border of European Russia. The yield of hay is 30 pood per dessiatine, which equals 2 tons per acre, and the yield of seed 26 pood per dessiatine, or 348 pounds per acre." (*Hansen.*)

28072. ALEURITES FORDII Hemsl. **China wood-oil tree.**

From Hankow, China. Procured through Mr. Hubert G. Baugh, vice consul general in charge. Received at the Plant Introduction Garden, Chico, Cal., April 27, 1910.

See No. 25081 for description.

28073 to 28092.

From Port-of-Spain, Trinidad. Presented by Mr. F. Evans, Botanical Department, Department of Agriculture. Received June, 1910.

Plants of the following; notes by Mr. Evans:

28073. ANEMOPAEGMA GRANDIFLORA Sprague.

A climbing plant, probably a native of Trinidad.

28074. ANONA SQUAMOSA L. **Sugar-apple.**

28075. BERTHOLLETIA NOBILIS Miers. **Brazil nut.**

Distribution.—The northern part of South America; in the valley of the Amazon and in Guiana.

28076. BLIGHIA SAPIDA Konig. **Akee.**

See No. 24592 for description.

28077. CARYOPHYLLUS AROMATICUS L. **Clove.**

See No. 27680 for description.

28078. CINNAMOMUM CAMPHORA (L.) Nees. **Camphor.**

Distribution.—The Provinces of Kiangsu, Chekiang, Fukien, Hupeh, and Kwangtung, in the Chinese Empire, in the island of Formosa, and in Japan. Commonly cultivated in India and many other countries.

28079. CINNAMOMUM ZEYLANICUM Garc. **Cinnamon.**

Distribution.—Probably a native of Ceylon; cultivated in most tropical countries.

28080. COFFEA LAURENTII Wildem. **Coffee.**

Distribution.—Found in cultivation at Lusambo on Sankuru River in the Kongo Free State, Africa.

28081. DIOSPYROS DISCOLOR Willd. **Mabola.**

See No. 26112 for description.

28082. DURIO ZIBETHINUS Murr. **Durian.**

"A large tree of the Malay Islands, producing a large fruit 10 by 7 inches, called durian, or civet-cat fruit, of which the cream-colored fleshy aril or pulp enveloping the seeds, like that of the jack-fruit, is the part eaten. The roasted seeds and the boiled unripe fruit are also eaten as vegetables." (*Watt, Dictionary of the Economic Products of India.*)

"The odor of this fruit is intensely disagreeable to many people." (*Fairchild.*)

28073 to 28092—Continued.

Distribution.—The Malayan Islands; cultivated in the Malay Peninsula.

See No. 27169 for previous introduction.

28083. GARCINIA MANGOSTANA L. **Mangosteen.**

See No. 25887 for description.

28084. MANGIFERA INDICA L. **Mango.**

Julie. Grafted plant. See Nos. 21515, 25861, and 26125 for previous introductions of this variety.

28085. MANGIFERA INDICA L. **Mango.**

D'or. Grafted plant.

28086. PERSEA AMERICANA Miller. **Avocado.**

28087. PSIDIUM GUAJAVA L. **Guava.**

Large, red fruited.

28088. PSIDIUM LAURIFOLIUM Berg. **Nicaraguan guava.**

See No. 26413 for previous introduction.

28089. SAPOTA ZAPOTILLA (Jacq.) Coville. **Sapodilla.**

28090. SPONDIAS DULCIS Forst. **We fruit or golden-apple.**

See No. 26470 for description.

28091 and 28092. THEOBROMA CACAO L. **Cacao.**

28091. *Alligator.* Seedling plants.

28092. *Forestera.* Grafted plants.

Distribution.—The forests of the Amazon and Orinoco valleys up to an elevation of 400 feet; cultivated and naturalized throughout tropical America and in the Philippines.

28095 to 28116.

From Chile. Received through Mr. José D. Husbands, Limavida, via Molina, Chile, May 25, 1910.

Seeds of the following; notes by Mr. Husbands:

28095 and 28096. CRINODENDRON PATAGUA Molina.

See No. 25489 for previous introduction.

28097 and 28098. JUBAEA CHILENSIS (Mol.) Baill.

28097. "Indian name '*Lilla.*' " The shorter, thicker class of Chile palm from which a fine table sirup is made.

28098. "Indian name '*Caucau,*' same as the preceding (S. P. I. No. 28097), but grows very tall and slim."

See No. 25612 for previous introduction.

28099 to 28109. JUGLANS REGIA L. **Walnut.**

28099. "A large variety. A fair per cent of this tree produces nuts with shells having 3 parts instead of 2."

28100. "The common variety, introduced by the Spaniards. The specimens selected were those having shells in 3 parts."

28101 to 28109. "Different strains grown in Chile for very many years. This year being a drought year the nuts are smaller than usual."

28095 to 28116—Continued.

28110. LAVATERA ASSURGENTIFLORA Kellogg.

"This deciduous shrub, from the island of Anacapa off the coast of Santa Barbara, and now, to some extent, cultivated, is one of rare beauty and grace. As an ornamental shrub, or tree, for it attains to the height of 15 feet, it will be highly esteemed when more generally known. The flowers are purple, about two and a half inches broad, and in this climate continue long in bloom." (*Kellogg, in Proceedings California Academy, vol. 1, p. 14. 1854.*)

28111 and 28112. MAYTENUS BOARIA Molina.

28111. "Weeping Maiten. Has a red bark and one seed in a pod; the seeds contain a quantity of oil."

28112. "*Maiten derecho.* Leaves and branches grow straight upright. Has white bark and two seeds in each pod, the seeds contain a quantity of oil."

See No. 26187 for previous introduction.

28113. NOTHOFAGUS sp.

From dry central Chile.

28114. PISUM ARVENSE L. **Pea.**

"Stringless peas, whose extra-large, sweet, thick pods are comestible like green beans."

28115. RICINUS COMMUNIS L. **Castor-oil bean.**

"Wild castor beans from the dry hills of Coquimbo."

28116. VILLARESIA MUCRONATA Ruiz. & Pav.

Nearly all of the publications on Chilean botany that include this species give *Citrus chilensis* Molina, 1782, as a synonym. If this citation is correct the specific name *chilensis* is earlier than *mucronata*, but with the material at present available it is impossible to establish their identity.

"*Gillipatagua.*"

Distribution.—A tree growing in the central provinces of Chile and extending as far southward as the region around Concepcion.

28117 to 28121. CERATONIA SILIQUA L. **Carob.**

From Lisbon, Portugal. Presented by Companhia Das Lezirias do Tejo e Sado. Received June 2, 1910.

Cuttings of the following:

28117. *Burro.*
28118. *Canella.*
28119. *Costella de Vacca.*
28120. *Galhosa.*
28121. *Mulata.*

28122 to 28124.

From Buitenzorg, Java. Presented by the Director of Agriculture. Received June 2, 1910.

Plants of the following:

28122. ATALANTIA BILOCULARIS (Roxb.) Wall.

See No. 24433 for description.

28123. FERONIA LUCIDA Scheffer.

Distribution.—The province of Rembang on the north shore of the island of Java.

28122 to 28124—Continued.

28124. GLYCOSMIS PENTAPHYLLA (Retz.) Correa.

Variety *dilatata*. See No. 24609 for previous introduction.

28125. SICANA ODORIFERA (Vell.) Naud. **Cassabanana.**

From Tampico, Mexico. Presented by Dr. Edward Palmer, through Mr. H. Pittier. Received June 6, 1910.

"A native of Brazil. Edible when still tender, but often cultivated on account of its odorous gourdlike fruits." (*Pittier.*)

See Nos. 27969 and 28012 for previous introductions.

28126. CAPPARIS SPINOSA L. **Caper.**

From near Petrovsk, Caucasus, Russia. Received through Mr. Frank N. Meyer, Agricultural Explorer, June 4 and 20, 1910.

"(No. 783, May 18, 1910.) The well-known caper plant, an herbaceous perennial, making long branches which crawl over the earth. Grows on very dry and stony places in the northeastern sections of the Caucasus, where occasionally winter temperatures of −20° C. (−4° F.) are experienced. Tens of thousands of rubles' worth of pickled capers are annually exported from the Caucasus, all gathered from wild plants. This caper plant may prove of value as a profitable crop for the more arid southwestern sections of the United States. As the plants require much space they should be planted at least 10 feet apart in all directions." (*Meyer.*)

Distribution.—Southern Europe and western Asia eastward to northern India, in northern Africa, and in Australia and the Sandwich Islands.

28128. MACHILUS NANMU (Oliv.) Hemsl.

From Yachow, West China. Presented by Mr. H. J. Openshaw. Received May 7, 1910.

"A splendid hard-wood tree which, I think, ought to grow in the lower altitudes. It is insect proof and is almost as hard as teak." (*Openshaw.*)

"*Nanmu*, sometimes erroneously called cedar, whereas it might be styled Chinese laurel, is the most famous of Chinese woods. Several species of Machilus and Lindera are called by the name *Nanmu;* and it is not yet quite certain which species yields the famous timber used in building the imperial palaces. This timber is said to come from Szechwan and Yunnan; and it is probable that it is produced by *Machilus nanmu* Hemsl., of which Davenport, Baber, etc., sent specimens from those provinces as yielding the famous wood. *Nanmu* also occurs in Fukien, and is there an excellent wood, capable of being used for making elegant writing desks and the like." (*Henry, Economic Botany of China, 1893: p. 43.*)

Distribution.—The provinces of Szechwan and Yunnan, in the Chinese Empire.

28129 and 28130. ZIZIPHUS spp.

From Maskat, Oman, Arabia. Procured by Mr. John A. Ray, American consul. Received June 1, 1910.

Seed of the following; notes by Mr. Ray:

28129. ZIZIPHUS MAURITIANA Lam.

"*Jarrai.* This variety has very hard seeds and the name is supposed to refer to the act of pulling the stones out of one's mouth and throwing them away."

See Nos. 23439 to 23446 and 25777 for previous introductions.

28129 and 28130—Continued.

28130. Ziziphus oxyphylla Edgew.

"*Qadhmani.* This name refers to the fact that they can be chewed up, stones and all. Some call them '*Makki,*' as they are thought to have been introduced here from the city of Mecca."

Distribution.—Found occasionally on the eastern flanks of the Sulaiman Range and in the outer Himalayas as far as the Ganges, in northwestern India.

"The jujube tree grows in this dry country without any attention or irrigation. The fruit is relished by the natives, but I do not think Americans will care for it. It has a taste vaguely resembling the red haw of Texas, if the memories of my childhood do not play me false. The English call the fruit I have sent you '*nubbuck apples.*' The Arabic name of the fruit is '*Nabaq,*' the tree is called '*Sidr.*'"

Note.—The Tournefortian genus Ziziphus was not recognized by Linnæus in his Species Plantarum but was united with Rhamnus, and the five species known to Linnæus were included as *Rhamnus lotus*, *R. jujuba*, *R. oenopolia*, *R. zizyphus*, and *R. spina-christi.* Ziziphus was, however, recognized as a distinct genus by a number of authors soon after the publication of the Species Plantarum in 1753. The first of these appears to have been Duhamel (Traité des Arbres, 1756, vol. 2, p. 377), with one species, followed by Miller (Gard. Dict., ed. 7, 1759), with four species, Adanson (Familles des Plantes, 1763, vol. 2, pp. 304, 620), with six species, and by other authors. The first of these authors to use the Linnæan binomial nomenclature was Philip Miller in the 1768 edition of the Gardener's Dictionary, and the four species of the 1759 edition are there included as *Ziziphus jujuba*, *Z. sylvestris*, *Z. oenoplia* [oenopolia], and *Z. africana.* Miller, however, did not apply the name *Ziziphus jujuba* to *Rhamnus jujuba* of Linnæus, for which species it has been almost universally used by subsequent authors, but to "The common Jujube," *Rhamnus zizyphus* of Linnæus (*Z. sativa* Gaertn. 1788, *Z. vulgaris* Lam. 1789). To conform to the present practice in specific nomenclature *Rhamnus jujuba* L. must therefore be known as *Ziziphus mauritiana* Lam., this being the next earliest available name applied to the species, while *Rhamnus zizyphus* L. becomes *Ziziphus jujuba* Miller. Miller's *Ziziphus sylvestris* is *Z. lotus* (L.) Lam. and his *Z. africana* is *Z. spina-christi* (L.) Willd.

28131. Anona reticulata L. **Custard-apple.**

From Manila, Philippine Islands. Presented by Mr. A. J. Perkins. Received April 16, 1910.

28132 to 28135.

Material being grown at the Subtropical Garden, Miami, Fla., to be used in plant-breeding work. Numbered June 13, 1910.

Plants of the following; notes by Mr. P. J. Wester:

28132. Anona reticulata L. **Custard-apple.**

"Bud wood secured in Nassau, New Providence, Bahamas, April, 1906, by Mr. P. J. Wester from a prolific seedling tree; fruit medium to large."

28133. Anona squamosa L. **Sugar-apple.**

"Plants received at the Subtropical Garden, Miami, Fla., April 23, 1909, from Dr. F. Franceschi, Santa Barbara, Cal., grown by him from seed obtained in Paraguay, South America."

28134. Psidium guajava L. **Guava.**

"Bud wood obtained by Mr. P. J. Wester from a seedling tree owned by Mr. J. O. Pardoe, Biscayne, Fla. Fruit medium large, yellowish; flesh, pale red;

28132 to 28135—Continued.

number of seeds, average. One of the best flavored guavas that has come to my attention.

28135. Rollinia emarginata Schlecht.

"Plants received from Dr. F. Franceschi, Santa Barbara, Cal., April 23, 1909, at the Subtropical Garden, Miami, Fla. Grown by Dr. Franceschi from seed obtained in Paraguay."

28136 to 28151. Ceratonia siliqua L. **Carob.**

From Portugal. Procured by Mr. Louis H. Aymé, American consul general, Lisbon. Received June 11, 1910.

Cuttings of the following:

28136 to 28142. From the Municipality of Lagôa (Silves).

- **28136.** From Manoel F. Gomes, Cotovio.
- **28137.** From Manoel F. Gomes, Serro dos Negros.
- **28138.** From Manoel F. Gomes, Boavista.
- **28139.** From Manoel F. Gomes, Gramacho.
- **28140.** From Gregoria José Luiz, Gramacho.
- **28141.** From Antonio Franco, Sintra, Boavista.
- **28142.** From José da Silva Ruivo, Serro dos Negros.

28143 to 28151. From the Municipality of Va. Na. de Portimao.

- **28143.** From D. Luiz Bordasy Marimon, Poco da Lage.
- **28144.** From D. Luiz Bordasy Marimon, Vao da Rocha.
- **28145.** From Visconde d'Alvôr, Serro dos Corcos.
- **28146.** From Dr. Alfredo Magalhães Barros, Chao das Donas.
- **28147.** From Antonio Trindade, Valle d'Arrencada.
- **28148.** From Antonio Trindade, Chao das Donas.
- **28149.** From Luiz Duarte, Sabolar.
- **28150.** From Amaro Duarte, Sabolar.
- **28151.** From Visconde da Rocha, Valle de Franca.

"My friend who procured these cuttings advises that in order that the carob trees bear every year, every tree ought to be grafted with a branch from the male carob, which is necessary to fecundate the flowers and thus avoid poor years." (*Aymé.*)

28152. Medicago sp.

From Baku, Caucasus, Russia. Received through Mr. Frank N. Meyer, agricultural explorer, June 13, 1910.

"(No. 784, May 26, 1910.) A perennial medicago of creeping habit; it has small racemes of blue flowers and small, scanty leaves. Grows on most remarkably dry and stony places and remains green after the other vegetation has turned brown. It is eagerly browsed by sheep and goats. As the climate around Baku is almost arid, this medicago may prove to be valuable in some of our driest sections of the Southwest." (*Meyer.*)

28153 to 28180.

From Wuchang, Hupeh, China. Presented by Director Whong, Chinese Government College of Agriculture, through Mr. Howard Richards, jr., Boone College, Wuchang. Received June 6, 1910.

Seeds of the following; Chinese names as given on the packets:

28153. Castanopsis sp.

Ber shin tze tree.

28154 and 28155. Cinnamomum camphora (L.) Nees. & Eberm.

28154. *Pei pai chang.* White camphor wood.

28155. *Hwar chong* tree.

28156. Citrus decumana (L.) Murr. **Pomelo.**

Shong yuen tree.

28157. Liquidambar formosana Hance.

Mow fong tree.

Distribution.—In the provinces of Kiangsi, Fukien, Hupeh, and Kwangtung, in the Chinese Empire, in the island of Formosa, and in Japan.

28158 to 28175. Oryza sativa L. **Rice.**

28158. *Bei kwoo lo.*
28159. *Bei yiu kwu.*
28160. *Hun mon lo.*
28161. *Hwong kwoo lo.*
28162. *Sung le lo.* Japanese variety.
28163. *Kwan tsu dow.*
28164. *Mon tsung ho.*
28165. *Sei kwan shü.*
28166. *Tsung ten.*
28167. *Tsung tien lo.*
28168. *Tse koo lo.*
28169. White.
28170. *Wan kwo.*
28171. *Woo mon lo.*
28172. *Wu mong lo.*
28173. *Ye zei lo.*
28174. *Yuen che lian lun.*
28175. *Zo tsen bow sung.*

28176. Quercus sp.

Ung se lai.

28177. Sorbus sp.

Yo dzor tsz.

28178. Thea sinensis L. **Tea.**

Red.

28179 and 28180. Trachycarpus excelsus (Thunb.) Wendl.

28179. Palm tree. **28180.** *Ju* tree.

See Nos. 26907 and 27456 for previous introduction.

28181. Psidium guajava L. **Guava.**

Grown at the Subtropical Garden, Miami, Fla. Numbered June 17, 1910.

Bud wood obtained May, 1909, by Mr. P. J. Wester from Mr. Orange Pound, Cocoanut Grove, Fla., for breeding purposes.

"This is a white-fleshed guava, rather larger than the average fruit found in the market and with seeds less numerous. In flavor it is mild and sweet. Mr. Pound claims to have found nearly seedless fruits on the tree." (*Wester.*)

28182. LARIX SIBIRICA Ledeb.

From Helsingfors, Finland. Presented by Miss Alexandria Smirnoff. Received June 1, 1910.

Distribution.—Province of Chihli in China, and in Mongolia and Manchuria.

See No. 2175 for previous introduction.

28183 to 28190.

From Mexico. Collected and presented by Dr. J. N. Rose, associate curator, Division of Plants, U. S. National Museum, Washington, D. C. Received May 23, 1910.

Seeds of the following:

28183 to 28185. CARDIOSPERMUM spp.

28183. From Guaymas.
28184. From Mazatlan.
28185. From San Blas.

28186 to 28189. DIOSPYROS spp.

28186. From Altata.
28187. From Guadalupe.
28188. From Hermosillo, Sonora.
28189. From Mazatlan.

28190. PHASEOLUS sp.

From near Villa Union, Sonora.

28191. NICOTIANA TABACUM L. **Tobacco.**

From Pirapo, Paraguay Presented by Mr. J. Eliot Coit, Southern California Laboratory, California Agricultural Experiment Station, Whittier, Cal. Received June 21, 1910.

"The friend from whom I received this seed described it as being a high-quality filler tobacco, which under extremely poor management is said to yield a leaf somewhat inferior to the Cuban, but decidedly superior to the American grown." (*Coit.*)

28193. SACCHARUM OFFICINARUM L. **Sugar cane.**

From Okinawa ken, Kiushu, Japan. Purchased from the Yokohama Nursery Co., Yokohama, Japan. Received June 22, 1910.

"*Yomitani yama.*" Early variety.

"Japanese sugar cane is now quite extensively grown in Florida and the southern portions of the States near the Gulf of Mexico. It is grown largely for forage and to some extent for sirup. Its use for forage is rapidly increasing. While it has been used successfully for ensilage, it is commonly fed green or pastured. Fields of this variety last as much as 12 years. The variety now grown in the Southern States was introduced about 12 years ago. The present variety is believed to be different from that originally introduced." (*C. V. Piper.*)

28194 to 28197.

From Guatemala. Presented by Dr. J. N. Rose, associate curator, U. S. National Museum. Received May 22, 1910.

Seeds of the following:

28194. BOUTELOUA BROMOIDES (H. B. & K.) Lag.

From Aguas Calientes.

Distribution.—Texas and Arizona and southward through Mexico to Nicaragua and Panama.

28194 to 28197—Continued.

28195. Echinochloa colona (L.) Link.

From Gualan.

Distribution.—Widely spread in the warm regions of both hemispheres.

28196. Panicum fasciculatum Swartz.

From Gualan.

Distribution.—Mexico, from the vicinity of San Luis Potosi, southward to tropical South America, and in the West Indies.

28197. Carica papaya L. **Papaya.**

From Gualan.

28198. Ananas sativus Schult. f. **Pineapple.**

From Sunnybank, near Brisbane, Queensland, Australia. Presented by Mr. John Williams, The Sunnybank Nursery. Received June 17, 1910.

"*John Williams Improved Smooth Leaf.* This is a cross of *Ripley Queen* and *Smooth Cayenne*, giving it a much better flavor, and the habit of *Cayenne*." (*Williams.*)

28199 to 28262.

From Cambridge, England. Presented by the director of the Botanic Garden, Cambridge University. Received May 7, 1910.

Seeds of the following:

28199. Agropyron cristatum (L.) Beauv.

Distribution.—In open sandy and stony places in eastern Germany and western Hungary.

28200. Bidens humilis H. B. & K.

Distribution.—Found at the base of the Volcano Cotopaxi in northern Ecuador.

28201. Bidens pilosa L.

Distribution.—Texas and New Mexico, southward through Mexico and Central America to Chile and southern Brazil; introduced throughout the tropics.

28202. Clematis montana Hamilton.

Distribution.—India, on the temperate slopes of the Himalayas from the Indus to the Brahmaputra, ascending to 12,000 feet, and in the Khasi Hills at an elevation of 4,000 feet and above.

28203. Cornus alba L.

Distribution.—Widely distributed in Siberia, extending eastward to the Amur, and to northern China. Cultivated as an ornamental shrub.

28204. Cornus amomum Miller.

Distribution.—Wet places from Newfoundland westward to North Dakota and southward to Florida and Louisiana.

28205. Cornus mas L.

Distribution.—From central Europe eastward through Italy and Greece to the Caucasus region of southern Russia. Cultivated in the United States as an ornamental.

28206. Cosmos sulphureus Cav.

Distribution.—Southern Mexico from Cordova to Oaxaca, rising to an elevation of 5,500 feet in the cordilleras of Oaxaca.

28199 to 28262—Continued.

28207. Cotoneaster affinis Lindl.

Distribution.—Northwestern Himalayas in the Province of Nepal, northern India.

28208. Cotoneaster affinis bacillaris (Wall.) Schneider.

Distribution.—The temperate slopes of the Himalayas from Waziristan eastward through Muree and Kashmir to Nepal, rising to an altitude of 10,000 feet.

28209. Cotoneaster horizontalis Decaisne.

Distribution.—The Province of Szechwan in western China. Cultivated as an ornamental.

28210. Cotoneaster racemiflora (Desf.) Koch.

Distribution.—The Caucasus region and Asia Minor eastward to western Tibet and Kashmir, where it is found at an elevation of 11,000 feet; also in northern Africa.

28211. Cotoneaster rotundifolia Wall.

Distribution.—Northern India; the slopes of the Himalayas up to 11,000 feet from Nepal eastward to Sikkim and Bhutan.

28212. Cotoneaster simonsii Baker.

Distribution.—Slopes of the Khasi Hills in the Province of Assam in the northeastern part of India.

28213. Cotoneaster tomentosa (Ait.) Lindl.

Distribution.—Mountains of southern Europe from the Pyrenees and Alps eastward to Macedonia.

28214. Cyclanthera explodens Naudin.

Distribution.—From the province of Orizaba in Mexico southward through Central America to the mountains of Ecuador.

28215. Daboecia cantabrica (Huds.) Koch.

Distribution.—The western coast of Europe; common on the heathy wastes of the Asturias and southwestern France, and extending northward to Connemara in Ireland.

28216. Dahlia gracilis Ortegies.

Distribution.—Northern Mexico; at an elevation of 6,000 to 8,000 feet in the region of San Luis Potosi.

28217. Erica ciliaris L.

Distribution.—Along the western coast of Europe from Ireland and southwestern England through western France to northern Spain and Portugal.

28218. Exacum affine Balfour.

Distribution.—Found on the island of Socotra on the east coast of Africa. Grown in the United States as a greenhouse plant.

28219. Festuca ampla Hackel.

Distribution.—In the vicinity of Coimbra in Portugal and on the Sierra de Alfacar and the Sierra Nevada in the vicinity of Granada in Spain.

28220. Impatiens oliveri C. H. Wright.

Distribution.—On volcanic rocks and tufa in the province of Uganda, British East Africa.

28221. Impatiens roylei Walp.

Distribution.—Temperate slopes of the western Himalayas from Nepal to Marri, India, at an elevation of 6,000 to 8,000 feet.

28199 to 28262—Continued.

28222. IMPATIENS SCABRIDA DC.

Distribution.—Shady woods of the temperate Himalayas at an altitude of 6,000 to 10,000 feet between Kunawar and Bhutan in northern India.

28223. LIMNANTHES DOUGLASSII R. Br.

Distribution.—Along the banks of the Umpqua River in western Oregon.

28224. LYSIMACHIA VULGARIS L.

Distribution.—On shady banks along streams in Europe and Russian Asia, from the Mediterranean and the Caucasus region northward to the Arctic circle. Naturalized in the United States from Maine to Ontario and southward to Ohio.

28225. MEDICAGO HISPIDA DENTICULATA (Willd.) Urban.

28226. MEDICAGO HISPIDA Gaertn.

28227. MEDICAGO ORBICULARIS MARGINATA (Willd.) Benth.

28228. MEDICAGO TRUNCATULA Gaertn.

Distribution.—The countries bordering on the Mediterranean from Spain through France, Italy, Greece and Asia Minor to Arabia, and in northern Africa.

28229. PRIMULA FLORIBUNDA Wall.

Distribution.—Slopes of the western Himalayas at an altitude of 2,500 to 6,500 feet, between Kumaon and Kashmir, also in Afghanistan.

28230. PRIMULA JAPONICA A. Gray.

Distribution.—Shady valleys among the mountains in the provinces of Hakone and Yeso in central Japan. Cultivated in the United States as an herbaceous perennial.

28231. PRIMULA MOLLIS Nutt.

Distribution.—The eastern Himalayas in the vicinity of Bhutan in northern India.

28232. PRIMULA ROSEA Royle.

Distribution.—Slopes of the western Himalayas from Kulu to Kashmir at an altitude of 10,000 to 12,000 feet; also Afghanistan.

28233. PRIMULA VERTICILLATA Forsk.

Distribution.—Along the streams running from mount Kurm into the Dead Sea, western Arabia.

28234. ROSA ALPINA L.

Distribution.—Alpine slopes of the mountains of central Europe, especially in the Swiss Alps.

28235. ROSA BLANDA Ait.

Distribution.—Northeastern America; from Newfoundland to New England and westward, chiefly in the region of the Great Lakes, to Missouri and Assiniboia.

28236. ROSA CANINA L.

Distribution.—In thickets and hedges throughout Europe extending to the Ural Mountains and Dzungaria; also in the Canary Islands and in northern Africa.

28237. ROSA GALLICA L.

Distribution.—Europe and western Asia; from Belgium and Spain eastward to Asia Minor and the Caucasus region.

28199 to 28262—Continued.

28238. × Rosa hibernica Smith.

Distribution.—A hybrid between *Rosa canina* and *R. spinosissima* arising in the counties of Derry and Down in Ireland.

28239. Rosa macrophylla Lindl.

Distribution.—In the Himalayas up to 10,000 feet between Murree and Sikkim, and in the provinces of Chihli and Yunnan in China.

28240. Rosa multiflora Thunb.

Distribution.—Apparently native throughout China, the Korean Archipelago and Japan; common in cultivation.

28241. Rosa rugosa Thunb.

Distribution.—The Provinces of Chihli, Shingking, and Shangtung in China, in the Korean islands, and in Japan.

28242. Rosa tomentosa Smith.

Distribution.—In hedges and thickets throughout Europe and western Asia, chiefly in the northern part, and in the mountainous districts of southern Asia.

28243. Rosa villosa L.

Distribution.—Mountains of Norway and Sweden southward to central Spain and eastward to the region of the Caucasus Mountains and Armenia.

28244. Rosa virginiana Miller.

Distribution.—Margins of swamps and rocky shores from Newfoundland to eastern Quebec and southward to New York and eastern Pennsylvania.

28245. Sambucus ebulus L.

Distribution.—Central and southern Europe and Asia Minor, northern Africa, and eastward through Persia to Kashmir and the Elburz Mountains.

28246. Tropaeolum majus L.

28247. Tropaeolum minus L.

28248. Ulex europaeus L.

Distribution.—On heaths and sandy and stony wastes in western Europe, extending eastward to northern and central Germany; abundant in England, Ireland, and Scotland.

28249. Viola arenaria DC.

Distribution.—Sandy and stony places in Europe from Norway and England southward to the Mediterranean, and in northern Asia.

28250. Viola canina L.

Distribution.—Very common throughout Europe and northern Asia.

28251. Viola cornuta L.

Distribution.—Southern Europe, especially in the Pyrenees.

28252. Viola cucullata Ait.

Variety *alba*.

Distribution.—In wet places throughout the northeastern United States.

28253. Viola elatior Fries.

Distribution.—Damp pastures and copses in northern and central Europe, thence eastward to the Altai Mountains and southward to Asia Minor.

28254. Viola ericetorum × ruppii.

28199 to 28262—Continued.

28255. Viola hirta L.

Distribution.—On rocks and in pastures throughout Europe and to the Caucasus Mountains and Asia Minor in southwestern Asia.

28256. Viola mirabilis L.

Distribution—Mountainous woods in Germany and Sweden and northern Russia, and southward to the Caucasus Mountains.

28257. Viola munbyana Boiss. & Reut.

Distribution.—On the slopes of Mount Beni-Salah near the village of Blidah, on the coast of Algeria.

28258. Viola odorata L.

Distribution.—On banks, under hedges, in woods, and on the borders of pastures over most of Europe and Asia, extending north to temperate Sweden.

28259. Viola persicifolia Roth.

Distribution.—Along canals and brooks and in swamps in southern and western Germany, and in Switzerland.

28260. Viola pratensis Mert. & Koch.

Distribution.—Damp pastures, meadows, and sandy banks of streams in Bohemia and the valley of the Rhine in Germany.

28261. Viola rostrata Muhlenburg.

Distribution.—Northeastern North America, from Quebec to Michigan and southward in the Alleghenies to Georgia.

28262. Viola tricolor L.

Distribution.—On hilly pastures and banks in cultivated and waste places throughout Europe and Asia. Sparingly persisting as an escape from cultivation in the United States.

28264 to 28266.

From Turkestan. Received through Mr. Frank N. Meyer, agricultural explorer, June 25, 1910.

Roots of the following:

28264. (Undetermined.)

From mountains near Bacharden, Turkestan. "(No. 785, June 6, 1910.) A very ornamental, low-growing, perennial plant belonging to the Silenaceæ; it produces a mass of dark rosy-red flowers in early June. Grows between rocks and bowlders on sunburned mountain sides; apparently prefers drained situations. Of value as a rockery plant in dry, hot regions." (*Meyer.*)

28265. Capriola dactylon (L.) Kuntze.

From Kizil Arvat, Turkestan. "(No. 787, June 2, 1910.) A crab-grass growing in the desert along the banks of dry rivers and irrigation canals. Seems to be the well-known Bermuda grass or a form of it. Recommended for testing as a lawn grass in dry and hot regions, as it forms a dense turf in its native haunts where camels and donkeys browse upon it." (*Meyer.*)

28266. Eremurus altaicus (Pall.) Stev.

From mountains near Bacharden, Turkestan. "(No. 788, June 5, 1910.) An ornamental Eremurus growing on dry mountain slopes between rocks and stony débris. It has columnar spikes of rosy-purple flowers. Probably of value as a garden ornamental in regions where aridity of the atmosphere prevails together with high summer and fairly low winter temperatures." (*Meyer.*)

28267 to 28273. IMPATIENS spp.

From Peradeniya, Ceylon. Presented by Mr. J. C. Willis, Director, Royal Botanic Garden. Received June 21, 1910.

Seeds of the following:

28267. IMPATIENS LATIFOLIA L.

Distribution.—Mountain slopes of the western peninsula of India from Konkan to Travancore, at an altitude of 3,000 to 7,000 feet, and in Ceylon and Java.

28268. IMPATIENS FLACCIDA Arnott.

Distribution.—Mountain slopes of the Malabar coast of southern India and in Ceylon, where it ascends to 3,000 feet.

28269. IMPATIENS GLANDULIFERA Arnott.

Distribution.—The Central Province of Ceylon at an altitude of 4,000 to 6,000 feet.

28270. IMPATIENS GIBBOSA Arnott.

Distribution.—Wooded slopes of the mountains in the Central Province of Ceylon, at an altitude of 5,000 to 8,000 feet.

28271. IMPATIENS MACROPHYLLA Gardn.

Distribution.—Wooded slopes of the mountains of Ceylon, at an altitude of 5,000 to 7,000 feet.

28272. IMPATIENS SULTANI Hook. f.

Distribution.—Introduced into cultivation from Zanzibar.

28273. IMPATIENS TRUNCATA Thwaites.

Distribution.—Wooded slopes of the mountains at an elevation of 4,000 to 6,000 feet in the Central Province of Ceylon.

28274. COFFEA ARABICA L. **Coffee.**

From Ponce, Porto Rico. Received through Mr. J. W. Van Leenhoff, agent and expert, Porto Rico Experiment Station, June 29, 1910.

Maragogipe. "This is a variety of coffee supposed to have originated as a mutation from the common Arabian coffee. It was discovered in Brazil about 1870. The leaves of this variety are much broader and the berries larger than in the ordinary type. The plants are very vigorous, but are usually shy bearers." (*G. N. Collins.*)

28275. MANGIFERA INDICA L. **Mango.**

From Miami, Fla. Presented by Messrs. Hickson Bros. Received June 23, 1910.

Cecil. "Form oblong, flattened, curving to a V-shaped beak about one-half inch from vertical center; size large or medium, about 4¾ by 2⅜ by 2¾ inches; stem medium slender, fleshy at union with fruit; surface moderately smooth; color greenish yellow marbled with rich yellow; dots numerous, subcutaneous, green and gray; bloom whitish; skin medium thick, tenacious; seed long, flat; flesh yellow, rather tender, juicy, very little fiber; flavor sweet, pleasant, aromatic; quality good to very good; season probably four to six weeks earlier than *Sandersha.*" (*W. N. Irwin.*) (Seed.)

28276 and 28277. MEDICAGO ARBOREA L.

From Maison Carree, Algeria. Presented by the Botanic Garden. Received June 30, 1910.

28276. (Cuttings.) **28277.** (Seeds.)

28278. MEDICAGO SATIVA L. **Alfalfa.**

From Pinchow, Shensi, China. Presented by Mr. Berthold Laufer, Peking, who procured them from Mr. Nelson, China Inland Mission, Pinchow. Received June 28, 1910.

"The young plants of this are much used for greens, and eaten by the people. For fodder it is nearly all used green. The Chinese do not dry much clover for hay. As a rule it is cut three times throughout the summer, not reckoning when they first pick the tender plants for greens. I think this variety will grow on most any kind of soil." (*Nelson.*)

28279 to 28285.

From Mexico. Presented by Dr. J. N. Rose, associate curator, U. S. National Museum, Washington, D. C. Received June 20, 1910.

Seeds of the following; notes by Dr. J. N. Rose:

28279 to 28282. CUCURBITA spp.

28279. From San Blas. Collected by Messrs. Rose, Standley, and Russell, in 1910. "A climbing vine; fruit nearly globular, yellow streaked with narrow bands of white, 3 inches long."

28280. From Culiacan. Collected by Messrs. Rose, Standley, and Russell. "A climbing vine; fruit globular or a little broader than long, streaked with alternating bands of yellow and white, 2½ inches long."

28281. From Mazatlan. Collected by Messrs. Rose, Standley, and Russell, April 4, 1910. "A climbing vine; fruit egg shaped, 4 inches long, dark green with yellowish markings."

28282. From Acaponeta. "A climbing vine; fruit oblong, 3½ inches long, lemon yellow, with narrow stripes of white."

28283. MALVAVISCUS sp.

From Mazatlan. "Shrub or small tree 10 to 20 feet high with large cordate leaves. The scarlet flowers are very attractive and are followed by globular scarlet fruit. This tree is cultivated in patios at Mazatlan, and I would suggest trying these seeds in Florida and southern California. Only a few species of Malvaviscus are in cultivation, although most of the species are very attractive. I have been unable to indentify the species, but it is a near relative of *Malvaviscus grandiflora.*"

28284. MOMORDICA ZEYLANICA Mill.

From near Culiacan. Collected by Messrs. Rose, Standley, and Russell, in 1910. "A vine climbing to the height of 10 to 20 feet, forming a dense mass of foliage and producing an abundance of small orange-colored fruits which open, exposing the bright-scarlet seeds. More delicate and attractive than the other species in cultivation. A splendid climber for trellis work."

28285. TABEBUIA sp.

From Alamos. Collected by Messrs. Rose, Standley, and Russell, in 1910. "A tree 20 feet high. Produces an abundance of large yellow Catalpa-like flowers which appear before the leaves. The leaves are compound and somewhat like the horse-chestnut. It would be a desirable ornamental shrub or tree for the arid part of the Southwest. It is probably an undescribed species."

28286 to 28289.

From Port Louis, Mauritius. Presented by Mr. G. Regnard. Received June 25, 1910.

Seeds of the following; notes by Mr. Regnard:

28286. DOVYALIS HEBECARPA (Gardn.) Warb.

"A fruit tree from Ceylon."

Distribution.—In the jungles of the Central Province of the island of Ceylon.

28287. ANONA sp.

"A species from Ceylon."

28288. COMBRETUM COMOSUM Don.

"Pretty, ornamental shrub."

Distribution.—Along Bagroo River in the vicinity of Sierra Leone in upper Guinea.

28289. FLACOURTIA RAMONTCHI L'Herit.

"A large-fruited thornless species."

See No. 26655 for previous introduction.

28290 to 28292. ANDROPOGON SORGHUM (L.) Brot. Sorgo.

From Island of Tsungming, China. Obtained by Mr. D. MacGregor, superintendent, parks and open spaces, Shanghai, China. Received June 25, 1910.

Seeds of the following; quoted notes by Mr. Carleton R. Ball:

28290. Early variety. "Apparently typical. Spikelets obovate; glumes black and shining, pubescent at tip; awned."

28291. Late variety. "Same remarks apply to this as to the preceding (S. P. I. No. 28290). This is the only sample yet received in which the seeds were all plump and mature."

"The two preceding lots are similar to or probably identical with S. P. I. No. 28024."

28292. Light-colored variety. "This differs from the preceding numbers in having reddish-brown glumes. Very few of the seeds are developed. It is probably identical with S. P. I. No. 28025."

28293 and 28294. ANONA CHERIMOLA Miller. Cherimoya.

From Nice, France. Presented by Dr. A. Robertson-Proschowsky. Received June 27, 1910.

28293. (Cuttings.) **28294.** (Seeds.)

"A very hardy variety found in my garden. The seeds may reproduce this hardy strain. The fruits are of no value." (*Proschowsky.*)

28296 to 28303. MEDICAGO FALCATA × SATIVA. Alfalfa.

Hybrid alfalfa plants. Parentage identical with S. P. I. No. 27742. Parents selected and hybrids made by Messrs. J. M. Westgate and W. J. Morse at the Arlington Experimental Farm during the summer of 1908. Numbered in the summer of 1910.

28296. Agrost. No. 2113. Sixth plant in row.

28297. Agrost. No. 2113. Seventh plant in row.

28298. Agrost. No. 2113. Eighth plant in row.

28296 to 28303—Continued.

28299. Agrost. No. 2113. Ninth plant in row.

28300. Agrost. No. 2113. Tenth plant in row.

28301. Agrost. No. 2113. Eleventh plant in row.

28302. Agrost. No. 2113. Twelfth plant in row.

28303. Agrost. No. 2113. Thirteenth plant in row.

28304 and 28305. ORYZA SATIVA L. **Rice.**

From Anam, French Indo-China. Procured by Mr. Miller Joblin, vice and deputy consul in charge, Saigon, Cochin China, from the chief of agricultural service in Anam. Received June 20, 1910.

Seeds of the following:

28304. *Lua Chum.* **28305.** *Luachiem.*

28306 to 28324.

From Russia. Received through Prof. N. E. Hansen, Agricultural Experiment Station, Brookings, S. Dak., May 20, 1910.

Seeds of the following; notes by Professor Hansen:

28306. AGROPYRON CRISTATUM (L.) Beauv.

"(No. 262.) This is considered a very valuable grass. Native of the driest steppes of eastern Russia and a large part of Siberia. The chemical analysis of this plant has attracted the attention of the Russian Government agronomists, indicating a higher percentage of protein than alfalfa. If this holds true under cultivation in the United States, it may be a verv valuable addition to our western grasses. Prof. R. W. Williams, of the Imperial Agricultural College at Moscow, Russia, is improving this species by selection from individual plants. The present sample is selection No. 1. The original seed was gathered from wild plants growing in the Turgai Province, the dry steppe region in western Asia just north of the Sea of Aral. This seed is from a single plant selected from the original plant raised at Moscow from this wild seed. Hence, the second generation under cultivation. The basis of selection in this selection No. 1 is a rather long and narrow inflorescence."

28307. AGROPYRON SIBIRICUM (Willd.) Beauv.

"(No. 272.) A grass native of the dry steppes of eastern Eruopean Russia and western Siberia. The present lot is selection No. 1, grown from a single plant, by Prof. R. W. Williams, of the Imperial Agricultural College, Moscow, Russia."

Distribution.—The trans-Caucasian provinces of southern Russia and eastward to the Altai Mountains in Siberia.

28308. AGROPYRON sp.

"(No. 275.) A native grass collected on the Russian Pamir plateau near the border of India in a six months' tour in 1899 by the late M. I. Toulinoff, assistant to Professor Williams at the Imperial Agricultural College, Moscow, Russia. The present sample is selection No. 1, by Professor Williams."

28309. TRIFOLIUM PRATENSE L. **Red clover.**

"(No. 280.) The native red clover from Uleaborg Province, Finland, from seed cultivated there about one hundred years. This is the original seed from the peasants, not cleaned or selected. Sample obtained from Professor Williams, Moscow."

28306 to 28324—Continued.

28310. Trifolium pratense L. **Red clover.**

"(No. 281.) The same notes as for No. 280 (S. P. I. No. 28309) apply to this, except that this sample is from the Vasa Province, Finland."

28311. Trifolium montanum L.

"(No. 282.) Native clover of Moscow Province, Russia. This is No. 617 of the plant-breeding numbers of Professor Williams, of the Imperial Agricultural College of Moscow, Russia."

Distribution.—Southern Europe and western Asia, extending from Spain through Italy, Dalmatia, central Russia, and the Caucasus region to the Ural Mountains in Siberia and the Savalan Mountains in northern Persia.

28312. Trifolium pannonicum Jacq.

"(No. 283.) A wild clover from the village of Lutovka, Kharkof Province, southern Russia. Sample obtained by Professor Williams, of Moscow. Should prove hardier than the Hungarian form of this species."

Distribution.—Southern Europe, extending from northern Italy through the Balkan Peninsula and southern Russia to Asia Minor.

28313. Trifolium lupinaster L.

"(No. 284.) This is a selection made from seed of wild clover gathered near Tomsk, Siberia. The original wild form was very low, 1 to 1½ feet, consisting of a single stem. The present sample is selection No. 1, and is the third generation from one plant grown by Professor Williams, of the Imperial Agricultural College, Moscow, Russia; it is rather high and bushy, with slender stalks and plenty of leaves."

28314. Pisum sativum L. **Pea.**

Field variety. "(No. 288.) A remarkable mutation appearing in the plant-breeding experiments at the Imperial Agricultural College, Moscow, Russia. It is No. 576 of Professor Williams, and was selected by his assistant, Rozinsky. It forms a single stem with all the seed at the top with 50 per cent of the weight going to seed. Value undetermined."

28315. Vicia sativa L.

"(No. 289.) A native vetch from Pskov Province, near Beloscrsk in the Baltic Sea region south of St. Petersburg. The peasants grind it for bread. They say it is good food for the table as well as for fodder and grain. Seed obtained by Professor Williams, of Moscow."

28316. Cucurbita maxima Duch.

"(No. 290.) A field pumpkin from Simbirsk Province, eastern Russia. Sample procured by Professor Williams."

28317. Physalis alkekengi L.

"(No. 291.) From seed saved by me from fresh fruit purchased in a bazaar at Samarkand, Turkestan, December, 1908. This is commonly sold strung on long threads. The bright-red inflated pods are quite ornamental."

Distribution.—Western Europe, through central Asia and in Japan; often cultivated.

28318. Lathyrus tuberosus L.

"(No. 292.) Seed gathered for me from plants growing wild in the dry steppe region at Orenburg in 1908 by courtesy of Mr. W. S. Bogdan, agronomist of the Turgai-Ural region, Orenburg Province, on the extreme eastern border of European Russia."

28306 to 28324—Continued.

28319. Glycyrrhiza glandulifera Waldst. & Kit. **Wild licorice.**

"(No. 293.) A native forage plant from the dry steppe region of Orenburg. Seed gathered for me in 1908, from wild plants, by courtesy of Mr. W. S. Bogdan, agronomist of the Turgai-Ural region, Orenburg Province on the extreme eastern border of European Russia. A relative of the cultivated licorice plant."

Distribution.—Southwestern Europe and southern Asia, extending from Greece through Persia, Turkestan, and Afghanistan to the province of Chihli in China.

28320. Avena sativa L. **Oat.**

"(No. 294.) Seed obtained originally from Nizhni Novgorod Exposition; sample grown in Kherson Province, southern Russia. The present sample is from seed raised for ten years by Professor Williams, of the Imperial Agricultural College, Moscow, Russia; the first five years as a field crop and the second five in the plant breeding plats. Noted for extreme earliness. At first the grain was very small, but is now larger and considerably later."

28321. Salsola arbuscula Pallas.

"(No. 295.) A native plant of arborescent growth, from the sand dunes of the Bokhara, gathered for me by courtesy of Mr. W. Paletsky, in charge of the sand-dune planting of the Trans-Caspian Railroad, with headquarters at Chardchui, Turkestan. This plant is used as a sand binder to prevent the moving sands from encroaching on the track. These experiments show great originality and demonstrate the superiority of the native plants of Turkestan for this purpose. The onward march of the moving sands has been checked. Formerly these caused great expense in railway management."

28322. Haloxylon ammodendron (Mey.) Bunge.

"(No. 296.) A native sand binder from Bokhara. Same source as No. 295 (S. P. I. No. 28321)."

28323. Calligonum caput-medusae Schrenk.

"(No. 297.) A native sand binder from Bokhara. Same source as No. 295 (S. P. I. No. 28321)."

28324. Trifolium pannonicum Jacq.

"(No. 113.) This is usually called Hungarian clover, a perennial allied to red clover, but earlier and less tender in foliage. This present sample deserves especial attention because it is as found wild in the Kharkof Province, southern Russia. It should prove hardier than the Hungarian form of the species."

PUBLICATION OF A NEW NAME.

27520. CERVICINA UNDULATA (L. f.) Skeels.

NOTE.—It seems desirable to call attention here to an unusual application of the name *Ziziphus jububa* in conformity with the accepted rules of specific nomenclature. See Introduction Nos. 28129 and 28130.

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 209.
B. T. GALLOWAY, *Chief of Bureau.*

GRIMM ALFALFA AND ITS UTILIZATION IN THE NORTHWEST.

BY

CHARLES J. BRAND,
Physiologist, Crop Physiology and Breeding Investigations.

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LETTER OF TRANSMITTAL.

3

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., January 9, 1911.

Sir: I have the honor to transmit the accompanying manuscript, entitled "Grimm Alfalfa and Its Utilization in the Northwest," and to recommend that it be published as Bulletin No. 209 of the special series of this Bureau. This paper was prepared by Mr. Charles J. Brand while Physiologist in Charge of Clover and Alfalfa Investigations, Crop Physiology and Breeding Investigations, and has been submitted by Mr. Walter T. Swingle, Physiologist in Charge, with a view to publication.

A general belief has prevailed for a long time that alfalfa, because of its lack of winter resistance, could never have the wide utilization in the Northwest that it enjoys in the States farther west and south. Repeated attempts in the cold, humid Northern States to grow the ordinary American sort, which is of South American origin, have usually resulted in discouraging failures, and conclusive experimental evidence has been lacking on which to base recommendations of other kinds.

The experiments that have been conducted leave no doubt that only a very few strains of alfalfa can be expected to succeed regularly in regions where severe winter conditions prevail. Of these Grimm alfalfa has proved to be the best, both in the experiments of investigators and in the experience of practical farmers.

The investigations of the Department of Agriculture and of the Minnesota, South Dakota, and North Dakota experiment stations and many experiments in cooperation with private individuals all point to the great value of this strain. Several thousand acres of Grimm alfalfa are now under cultivation, giving a basis for seed production of the greatest value. It is the purpose of the present bulletin to bring about the general utilization of this strain in the large area to which it is suited by arousing widespread interest in it and fostering seed production. The proper utilization of Grimm alfalfa should result in time in a great addition to the annual value of our agricultural products.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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GRIMM ALFALFA AND ITS UTILIZATION IN THE NORTHWEST.

INTRODUCTION.

Grimm alfalfa is distinguished from other strains or varieties chiefly by its resistance to the severe winter conditions of the northern United States, including North Dakota, South Dakota, Minnesota, Wisconsin, Michigan, New York, Pennsylvania, and New England; also the northern portions of Nebraska, Iowa, Illinois, Indiana, and Ohio, and parts of Montana.

In his annual report for 1907 the Secretary of Agriculture predicted that the extension of alfalfa over large areas where it is not grown at present would be a prize worth hundreds of millions of dollars yearly. There are three great areas of the United States where up to now regular success has not been attained in the growing of alfalfa. These briefly are (1) the humid Eastern and Southern States; (2) those parts of the semiarid region where irrigation water is not available, especially in the drier parts of the Great Plains and Intermountain country; and (3) the northern part of the United States with its severe winter climate. The general extension of alfalfa over any or all of these great areas will certainly mean the addition of many millions to the annual value of our agricultural products.

It is believed that in Grimm alfalfa we have a race of almost inestimable value for at least one of these areas—the cold northern country. This variety is of such unusual promise that it seems desirable to give a fairly complete account of its history, behavior, and possibilities.

WENDELIN GRIMM.

Wendelin Grimm, who introduced alfalfa into Minnesota in 1857,[a] was born in October, 1818, in the little village of Külsheim, in the northern part of the Grand Duchy of Baden. This little German settlement is located in a splendid agricultural section about midway between Wertheim on the Main and Bischofsheim on the Tauber. Grimm lived at Külsheim until the spring of 1857, when he was in the fortieth year of his age. Like so many sturdy German farmers, he looked to America as the land of great opportunities and decided to seek his fortune there. In May, 1857, he left Baden, determined to go to Minnesota, a State in which many of his countrymen had made new homes. He reached Chaska, Carver County, Minn., about September 1, and located on the northwest quarter of section 4, township 116 north, range 24 west, in Laketown. The substantial home that he built there later is still standing, though now under different ownership.

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[a] A brief account of the history of Grimm alfalfa by the present writer appeared in Science, n. s., vol. 28, December, 1908, pp. 891–892, under the title "The Acclimatization of an Alfalfa Variety in Minnesota."

The old farm contained only 137 acres, but under Grimm's thrifty management it yielded a good living and sufficient profit so that in 1876 a more desirable place near town was purchased. On the new farm, which is now owned by his son-in-law, Mr. Grimm spent the remainder of his days. He died in December, 1891, at the age of 73 years. At this time his alfalfa had not yet attracted more than neighborhood attention, hence exact details as to his experience are lacking. The account given here has been secured from his sons Frank and Joseph and from a number of his neighbors. His sons agree that the original lot of seed brought from Germany did not weigh more than 15 or 20 pounds. This seed was sown in the spring of 1858.

Joseph Grimm, the elder son, says: "Six years after planting this clover my father built a bank barn on this place about 12 feet above level ground. We had to dig a driveway 10 feet deep to get into this barn, and we found the roots of this clover had penetrated more than 10 feet deep through the clay soil. My father said this clover needed drained soil and would not do well on sandy or low ground."

Mr. George Du Toit, of Chaska, Minn., who became acquainted with Mr. Grimm over thirty-five years ago and sold him many of his garden and field seeds, states that he was not an educated man, though he had the rudiments of a good German education. Mr. Du Toit says: "He was a splendid farmer, full of common sense, and determined in what he undertook."

Another old settler and neighbor to Mr. Grimm, Mr. Henry Gerdsen who is himself an excellent farmer, characterizes Mr. Grimm in a very similar manner. Mr. Gerdsen, who located in Carver County even earlier than Grimm, recounts some interesting stories of how Mr. Grimm's alfalfa proved its value in the early days. One of these stories deserves telling in this connection. The summers of 1863 and 1864 had been unusually dry, but in the spring of 1865 Grimm, on his way to market, drove past Gerdsen's place a small bunch of fat cattle. As feed was very scarce and his own and other neighbors' cattle were lean, Mr. Gerdsen expressed his surprise and asked how the stock had been fattened, saying, "You must have grown corn." Mr. Grimm, who was even in that early day an alfalfa enthusiast, having become familiar with the great value of the crop in his German home, straightened up and answered proudly, "Kein Körnchen, nur ewiger Klee" (Not one kernel, only everlasting clover).[a]

The section of Baden from which Mr. Grimm came is known as the Bauland (farmland). It extends, in general, from the valley of the Neckar to the valley of the Tauber and is one of the most intensively cultivated portions of Germany. Its soil is of Jurassic origin and is rich in shell lime.

DESCRIPTION OF GRIMM ALFALFA.

To the casual observer Grimm alfalfa looks very much like all other alfalfas, but on closer examination it is found to be considerably more diverse than most kinds, showing individuals of upright and decumbent growth next to one another and showing a greater diversity in flower color than prevails in common alfalfa. All alfalfa has a certain range of flower color, but the Grimm has more than most cultivated sorts. The origin of this diversity can probably be traced to crossing in middle Europe between cultivated fields of true alfalfa (*Medicago sativa*) and neighboring isolated wild plants of the yellow-flowered sickle lucern (*Medicago falcata*). These two species intercross with considerable freedom. The percentage of crossing that has taken place is necessarily very small because of the scarcity of plants of the wild parents. It is more or less evident in practically all European alfalfa, but especially in that which is imported from Germany, Austria, Roumania, and the Piedmont region of Italy. The Provence and Poitou alfalfas of France also show this kind of diversity to a large extent.[b]

Recently there has been considerable interesting discussion among alfalfa breeders as to the importance of the presence of this exceedingly small percentage of falcata blood in Grimm and other European alfalfas, and a belief has grown that the proportion of falcata blood determines directly the degree of hardiness of this strain of alfalfa. On this basis the greater the proportion of falcata in a strain the hardier it should be. Experiments by the writer have not borne out this view, as other strains which give evidence of a higher percentage of falcata blood have proved to be far less hardy than Grimm alfalfa. Still other varieties that show no indication whatever of the presence of falcata influence, such as Mongolian alfalfa and Wheeler's acclimatized Turkestan alfalfa (S. Dak. No. 240), which was developed from Hansen's original importation, were much hardier than any except the Grimm that showed evidence of this cross. It seems possible, therefore, that the effect of occasional crossing with *M. falcata* has not been to transmit hardiness directly, but by producing diversity to give greater opportunity for the environment to develop a strain of greater hardiness. The value of diversity in this respect has recently been discussed by Mr. O. F. Cook.[a]

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[a] In various parts of Germany a number of different names are applied to alfalfa, but Mr. Grimm used the names common in Baden and the neighboring portions of Wurttemberg and Bavaria, namely, "ewiger Klee" (everlasting clover), referring to its perennial nature; other names are "Monatsklee" (monthly clover), referring to the frequency with which it can be cut; and "gemeine oder gebaute Luzerne" (common or cultivated alfalfa), in distinction to related species which occur wild scatteringly through this region and in fact through practically all of Europe and western Asia.

[b] Accurate statistics, prepared by Prof. L. R. Waldron, showing the extent of diversity in flower color for a large number of Old World strains of alfalfa, were published in Science, n. s., vol. 33, February, 1911, pp. 310-312, in an article entitled "Variegation of European Alfalfas."

Inasmuch as *Medicago falcata* is a species which has extraordinarily wide distribution it must vary greatly in hardiness. It ranges north and south from Italy to middle Norway in Europe and from India to Siberia in Asia, and ranges east and west from England almost to Korea.[b] The strain that has perpetuated itself in the mild climate of Baden, where some of the choicest of the Rhine wines are produced and where the almond and walnut flourish, would probably not be able to transmit any noteworthy degree of hardiness, but would by reason of cross-fertilization with *Medicago sativa* be extremely valuable in producing diversity. Hence it appears that Grimm alfalfa as it exists to-day is a direct product of diversity and selection due to environment. Through a period of 50 years lines of descent unfit to endure severe winter conditions have been eliminated, while fit lines have been perpetuated. The term "selective acclimatization" has been applied[c] to this process.

In another place[d] attention has been called to the fact that cultivated alfalfa is composed of numerous diverse strains, some of them being sufficiently distinct to constitute varieties or possibly even subspecies. These different races have very different forage and seed-producing values. The diversity of Grimm alfalfa as to certain characters is greater than that of our common western alfalfa. This is not so true of its habit of growth, leafage, etc., as it is of the color of the flower heads. In respect to this Grimm alfalfa is more diverse than any of our ordinary American or Chilean alfalfa.[e] It is no more diverse than some and but little more diverse than other strains of common alfalfa grown in middle Europe, such as the "altdeutsche fränkische," the Eifeler, the Pfalzer, and certain other kinds including notably the Provence and Poitou alfalfas of France and the strain secured from the Piedmont region of Italy.

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[a] Cook, O. F. Aspects of Kinetic Evolution. Proceedings of the Washington Academy of Sciences, vol. 8, February, 1907, pp. 197–403.

[b] Matsuda, S. On Medicago Sativa and the Species of Medicago in China. Botanical Magazine, Tokyo, vol. 21, No. 251, December, 1907, pp. 317–328. (In Japanese.)

[c] Brand, C. J., and Waldron, L. R. Cold Resistance of Alfalfa and Some Factors Influencing It. Bulletin 185, Bureau of Plant Industry, 1910, p. 67.

[d] Brand, C. J. Peruvian Alfalfa: A New Long-Season Variety for the Southwest. Bulletin 118, Bureau of Plant Industry, p. 18.

[e] Attention was first directed to this diversity in flower color by Mr. J. M. Westgate, of the Bureau of Plant Industry, who gives an extended discussion of it in Bulletin 169 of this Bureau, entitled "Variegated Alfalfa."

The usual range of flower color in our common alfalfa includes violet,[a] lavender, purple, light indigo blue with tinges of purple and violet, and sometimes in older flower heads a tendency to paleness, resembling cream color. These colors are given in the order of their frequency of occurrence. In Grimm alfalfa these same color types predominate, but there is present a small percentage of at least three other elements which are as follows:

(1) Heads of variegated colors, generally light lavender or Nile blue, with a malachite-green tinge and indigo-blue veins on the standard; the basal flowers cream colored or whitish, with a tinge of pale green.

(2) The characteristic blackish or smoky-colored flowers that occur in such profusion when the wild, yellow-flowered *Medicago falcata* (sickle lucern) is crossed with the cultivated alfalfa (*Medicago sativa*). This flower color is very uncommon in Grimm and traces its presence to the next color element mentioned below.

(3) Light yellow-colored flower heads. These are of extremely rare occurrence and the number varies somewhat with the different cuttings, depending upon the character of weather that prevails. During the summer of 1909 a field of about 30 acres was carefully examined and only about 15 yellow-flowered plants were discovered.

The occasional crossing at some time with the yellow-flowered plants explains the rest of the diversity in color that Grimm and European alfalfas show as compared to our ordinary form from South America. This diversity in color probably arose from chance crossing in Europe between wild plants of the sickle lucern growing near fields of cultivated alfalfa. The percentage of procumbent plants present in the Grimm strain does not exceed that which occurs in many of our other cultivated alfalfas and is probably much less than that of most Turkestan alfalfas, large quantities of which are now used yearly by American farmers.

WHAT RACE WAS THE PROGENITOR OF GRIMM ALFALFA?

Külsheim, Grimm's home, is less than a hundred miles distant from that part of the Rhine Valley in the Bavarian Palatinate (Pfalz) where alfalfa was first introduced into Germany, according to Heresbach, about 1570.[b]

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[a] The names of colors are based on The Nomenclature of Colors, by Robert Ridgway, Boston, 1886.

[b] Langethal, C. E. Handbuch der Landwirthschaftlichen Pflanzenkunde und des Pflanzenbaues, Klee und Wickpflanzen Berlin, 1874, p. 6.

In the valley of the Tauber in Wurttemberg and Baden, known as the Taubergrund, a highly prized strain of alfalfa has been grown for several centuries. This strain is called old German or old German Franconian lucern (alt-deutsche oder alt-deutsche fränkische Luzerne). This is the strain grown by Grimm's kinspeople who still live at Külsheim. It is considered far more valuable than the Provence or French lucern and its seed brings a much higher price. The Department of Agriculture, through the writer, has succeeded recently in securing a number of lots of seed of this variety. These are described in the inventories of the Office of Seed and Plant Introduction.[a]

At the request of the writer, Mr. Ludwig Keller, of Oberschüpf, Baden, made some inquiries into the history of old German Franconian alfalfa. The following, in free translation, is quoted from his report:

> This lucern was probably introduced into this country [Germany] at a very early time. It has adapted itself to the existing local conditions and has developed into a special strain of a certain constancy. Doubtless it is the same alfalfa that Farmer Grimm took with him to America. No other form is cultivated in our section on account of the superiority of this one.

This strain of alfalfa has now been grown for three seasons in this country in comparison with the Grimm variety, and their botanical identity is undoubted. It seems, therefore, that the highly prized old German form is truly the progenitor of the Grimm strain. Mr. Alois Grimm, of Külsheim, Baden, a kinsman of Wendelin Grimm, in a letter dated November 5, 1908, states that he grows the old German Franconian strain by preference and that other kinds than this and the Provence are unknown in his region. He also calls attention to the fact that a seed-grower's union has been established to foster seed production of the old Franconian variety.

According to Professor Wagner,[b] of Ettelbrück, Luxemburg, there is no doubt that this strain, both through long cultivation and because of care employed in the methods of seed production, has become acclimated to endure more extreme conditions. According to him its stands usually last from eight to twelve years, while the Provence lucern begins to get much thinner in three or four years, so that it is soon necessary to plow it up. Farmers in this region make a practice of saving seed from old stands in order to have the benefit of selection in getting rid of the weaker individuals.

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[a] Bulletin 137, Bureau of Plant Industry. Seeds and Plants Imported, Inventory No. 14, January, 1909, p. 56, and Bulletin 162 of the same series, Inventory No. 18, December, 1909, p. 42.

[b] Wagner, J. P. Der Luzernebau und seine Wiederbelebung. Berlin and Brandenburg, 1905.

CLIMATIC CONDITIONS ENDURED BY GRIMM ALFALFA.

A brief study of the climate of the part of Baden from which Mr. Grimm brought his alfalfa makes possible a comparison with the Minnesota climate that it has endured since 1858.

Accustomed to the vastness of our own country, we often forget that the whole area of Germany is only two and a half times greater than that of Kansas. It follows that Germany does not possess the wide diversity of climatic conditions that characterizes the United States. Baden itself has only a little more than two-thirds the area of Vermont and comprises the warmest part of Germany. The grapevine is extensively cultivated, and Wertheim, near Mr. Grimm's old home, is the seat of production of the well-known Wertheimer wines. The whole valley of the Tauber produces wines which are generally designated under the name of "Tauberwein." Small as Baden is, more than 250,000 acres of the Grand Duchy are devoted to alfalfa and clover culture.

For Wertheim, only 6 or 7 miles distant from Külsheim, temperature records that extend back to 1873 are available. No records exist for any point as near as Wertheim to Külsheim for the period preceding 1857, but the interim between 1873 and the present makes fairly certain the nature of the climate over a long period. Table I gives a comparison between certain features of the climate of Wertheim with other points in Germany and in the United States, including St. Paul.

Table I.—*Mean monthly, annual (mean and extremes), and mean winter temperatures for St. Paul, Minn., Wertheim, Germany, and certain other places.* [a]

Station.	Period.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.			Winter, mean.
														Mean.	Maximum.	Minimum.	
		°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
St. Paul, Minn.	....	12	16	29	48	60	66	74	72	62	50	32	20	45	104	−41	16
Wertheim, Baden	1873–1907	32	33	39	48	56	62	65	63	57	48	38	34	48	95	−22	33
Santa Fe, N. Mex	....	29	32	40	47	56	66	69	68	61	51	39	31	49	97	−13	30
St. Louis, Mo.	....	32	34	44	57	66	76	80	78	70	59	44	36	56	107	−22	34
Bismarck, N. Dak.	....	7	9	22	43	59	64	70	68	57	44	26	15	40	106	−44	10
Mergentheim, Wurttemberg	....	29	35	39	49	57	64	66	65	58	48	38	32	48	....	−19	32
Manhattan, Kans.	....	26	30	40	54	64	73	78	76	68	55	40	30	53	115	−32	29
Berlin, Germany	1719–1848	30	33	38	47	56	63	65	64	58	48	39	34	48	100	−20	32
Do.	1848–1907	31	34	39	48	57	64	66	65	58	49	39	33	49	99	−13	33
Breslau, Germany	1791–1854	27	30	35	46	55	61	64	64	56	48	37	30	46	100	−19	29
Prague, Austria	1851–1890	30	32	38	47	56	63	67	65	59	49	38	31	48	94	− 7	31

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[a] In the preparation of this table the official reports of the United States Weather Bureau and of the meterological bureau of the Grand Duchy of Baden, as well as monographs of Platz, Singer, Behre, Galle, and others have been utilized. Berlin, Breslau, and Prague were added to the table to show the general type of climate that prevails throughout middle Europe.

It will be seen from the mean temperatures shown in Table I that the winter climate of Wertheim is far milder than that of St. Paul, so much milder, in fact, that it is surprising to see a strain of the hardiness of the Grimm originate under such conditions. Grimm alfalfa in the beginning did not have the high percentage of hardy individuals that it now possesses. This is apparent on examining some of the old fields of this strain in Carver County, which range in age from 12 to 40 years, and also by comparing its behavior under identical conditions with the "alt-deutsche fränkische Luzerne," from which there is strong reason to believe it sprang. The old fields have gradually deteriorated in stand until only the hardiest individuals remain.[a]

Plate I, figure 1, from a photograph of a 25-year-old field on the Bender farm near Chaska, Minn., shows only partially the selective elimination which this field has endured. Not all of the plants that remain are as old as the stand itself. In fact, there is strong reason for believing that a considerable part of the plants now in the stands originated from seed that fell from older plants.

In comparative experiments with Grimm alfalfa and the old German Franconian alfalfa the latter has proved to be much less hardy under our northern conditions than the Grimm, which points to the probability that the German lucern that Mr. Grimm brought with him has been greatly modified during its fifty years' sojourn in Minnesota. In an experiment at Dickinson, N. Dak., under identical conditions and with identical treatment, adjoining rows of these strains killed out very differently. In the old German strain 64 out of 85 plants winterkilled, while in a sample of Grimm grown in North Dakota only 2 out of 70 plants were killed. In other words, the Grimm killed out less than 3 per cent, while the old German lost more than 75 per cent.

To further characterize the climate of Baden and some other European points as compared with our own climate, Table II, showing the absolute minima for a period of years, is inserted.

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[a] In a letter to the writer dated October 18, 1909, Mr. George Du Toit made the following statement: "I had called on him [Grimm] many times in driving by his farm a few miles from town, and became much interested in his determined efforts to raise an alfalfa that would stand our severe climate. He told me about his bringing a few pounds of seed with him when he came to this country from Baden, where he was born, and the time he had to save a portion of his seed, as time and time again the severe cold of those days killed it out. But he was a determined man * * * and kept at it until finally he won out and at last had a 'Grimm strain' that would stand our climate. Then gradually his neighbors followed him when they saw the great value of this clover, and to-day you can scarcely find a farm in Carver County that doesn't have a field of alfalfa." Mr. Du Toit was under the impression that Mr. Grimm had later sent back to Germany for seed, but inquiries addressed to his relatives and others fail to confirm this belief.

TABLE II.—*The lowest temperatures for each year for St. Paul, Minn., Wertheim, Germany, and certain other places, 1873 to 1907.*

Year.	St. Paul, Minn.	Wertheim, Baden.	Santa Fe, N. Mex.	Mergentheim, Wurttemberg.	Bismarck, N. Dak.	St. Louis, Mo.
	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*
1873	−33	13	−2	7	....	−23
1874	−23	−1	0	−1	....	−2
1875	−32	−7	2	−7	−34	−18
1876	−27	4	−1	−1	−30	−5
1877	−24	6	2	7	−30	−6
1878	−13	7	−2	3	−20	−6
1879	−39	−9	−13	−16	−38	−16
1880	−27	−10	−11	−11	−28	−6
1881	−25	−10	−9	−11	−34	−12
1882	−18	12	−1	7	−24	−6
1883	−31	10	−13	12	−37	−4
1884	−31	9	−2	3	−40	−22
1885	−36	2	−3	0	−36	−10
1886	−34	5	−6	4	−37	−8
1887	−36	−8	−8	−6	−44	−10
1888	−41	−8	−2	−17	−37	−12
1889	−25	−9	−1	−7	−34	0
1890	−22	4	2	5	−35	4
1891	−25	−16	−6	−10	−33	4
1892	−25	−3	1	−6	−34	−2
1893	−26	−22	5	−15	−41	−2
1894	−25	5	0	3	−33	−11
1895	−26	−12	−11	−19	−39	−12
1896	−18	13	7	12	−23	5
1897	−26	15	−1	16	−36	−2
1898	−19	16	−6	18	−18	3
1899	−33	5	−5	−3	−37	−16
1900	−18	15	7	14	−33	1
1901	−25	−7	1	−10	−26	−10
1902	−18	7	8	5	−29	−2
1903	−24	10	−4	7	−41	−6
1904	−33	14	0	9	−35	−6
1905	−26	2	−3	−1	−39	−18
1906	−17	10	0	6	−28	5
1907	−22	6	5	5	−39	3
Average	−26.4	1.9	−2	0.06	−33.4	−6.5

A study of this table shows that in the period that elapsed between 1873 and 1907 only 13 winters at Wertheim had minima below zero Fahrenheit, while 22 had minima above zero. During the same period St. Paul has never experienced a single winter with a minimum above zero. Only once in thirty-five years did Wertheim's minimum fall below −20° F., while at St. Paul only 6 out of 35 winters had minima above −20° F. Only two of Wertheim's minima are lower than the highest minimum (−13° F. in 1878) experienced in St. Paul during the period. According to the record the lowest temperature ever experienced at Wertheim was −22° F., while the lowest at St. Paul was −41°. St. Louis, which has almost the same absolute minimum as Wertheim, has had only 7 winters since 1873 with minima above zero, as compared with 13 for Wertheim. Mergentheim, with an absolute minimum for the period of −19° F., is located more nearly at the center of seed production of alfalfa in Franconia (Franken) than Wertheim. Bismarck and St. Paul are inserted in the table to illustrate in a measure what alfalfa must endure in the way of low temperatures in a large part of our

Northwest. The test is a severe one. The data which have now been collected indicate that Grimm alfalfa will endure these conditions in a fuller measure than any other known cultivated variety of *Medicago sativa.* It came from a region where the mean duration of the frost period[a] is about forty days and has now for years been grown successfully in the Minnesota climate, where the mean duration of the frost period is almost one hundred and forty days.

The mean annual and mean winter temperatures for Wertheim and Berlin are almost identical (Table I), although Berlin is considerably farther north than Wertheim. According to Behre,[b] Berlin, in the sixty years that intervened between 1847 and 1907, experienced only 30 winters the mean temperatures of which fell below the freezing point. The coldest of these had a mean of only 27° F. (−3.3° C.). St. Paul, on the other hand, during a period of fifty-four years, extending from 1854 to 1908, did not experience a single winter with a mean as high as 32° F., against Berlin's 30 winters, and the mean of the warmest winter St. Paul[c] has experienced (27° F.) is identical with that of Berlin's coldest winter.

In the one hundred and seventy-eight years that intervened between 1729 and 1907 Berlin had a total of only forty-four days with minima of 0° F. or below. Minnesota not infrequently has as many days of severe weather in a single winter. The absolute minimum at Berlin in this long period was −20° F.

The winter mean (December, January, February) at Berlin is 33° F., identical with that of Wertheim and one degree warmer than the November mean at St. Paul. In other words, the winter in Baden is about as cold as November in Minnesota. The winter mean for St. Paul from 1854 to 1904 is 13.4° F., while its coldest winter, that of 1874–75, had a mean of 3.7° F.—the winter that Mr. George Du Toit remembered as having been so destructive to Mr. Grimm's alfalfa. It seems almost axiomatic to say that Grimm alfalfa as it exists to-day is the product of a half century of the most rigorous selection for cold resistance endured by any race of alfalfa of which we have knowledge.

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[a] Dorscheid, O. Die mittlere Dauer des Frostes auf der Erde. Meteorologische Zeitschrift, Brunswick, 1907, vol. 24, pp. 60, 62.

The method of expressing severity of winter conditions by the duration of the frost period appears to be an unusually instructive one, especially for regions where the fluctuations between nocturnal and diurnal temperatures are not excessive, as is the case in all of the United States except in the arid regions. The duration of this period is found by determining the mean date on which the mean daily temperature passes below the line of the freezing point in autumn until it rises above this in spring. Hence the frost period as defined by Dorscheid extends from the day in autumn when the normal passes below 32° F. until the day in spring when it again rises above 32° F. These dates for Wertheim are December 18 and January 26, respectively, while for St. Paul they are November 11 and March 24, respectively. The mean duration of this same period for Salt Lake City, where common alfalfa is grown with perfect success, is fifty-two days, while for St. Louis, Mo., it is twenty-five days, and for Santa Fe, N. Mex., forty days. St. Paul's winter temperatures resemble rather closely those of St. Petersburg, Russia, while Wertheim's are similar to those of St. Louis, Mo., and of Santa Fe, N. Mex.

[b] Behre, O. Das Klima von Berlin, Berlin, 1908, p. 53.

[c] Stockman, William B. Invariability of Our Winter Climate. Monthly Weather Review, May, 1904. This short but excellent paper should be in the hands of every student of cold resistance in our crop plants. Reprints may be obtained by application to the Chief of the Weather Bureau, U. S. Dept. of Agriculture, Washington, D. C.

HARDINESS OF GRIMM ALFALFA IN COMPARISON WITH OTHER KINDS.

EARLY EXPERIENCES IN CARVER COUNTY.

The existence of a small localized alfalfa industry in Carver County, Minn., for more than a generation is of itself significant. If, as seems likely, the seed Mr. Grimm brought with him was the old German Franconian alfalfa, he had a somewhat superior basis on which to begin building a hardy race. The Provence and Poitou alfalfas of France, which occur in large quantities in commerce, would probably have presented somewhat greater difficulties in acclimatization. The great range of variation occurring in practically all kinds of alfalfa adapts this crop especially for acclimatization. Even our common alfalfa, in its progress eastward and northward to Nebraska and Montana, appears to have undergone a high degree of adaptation toward endurance of cold.[a] Indeed, such tender strains as the Peruvian and Arabian show great diversity in hardiness of individual plants. In fact, the Arabian alfalfa, which is the most sensitive to cold of any of which we have knowledge, is now being subjected to selection to produce a hardy strain of this valuable rapid-growing sort.

In addition to the advantage of a superior strain to begin with, Mr. Grimm had the characteristic German perseverence. In his first attempts he suffered many setbacks, and according to Mr. Charles Kenning, of Bird Island, Minn., he made but little headway for a number of years.[b]

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[a] See Bulletin 185, Bureau of Plant Industry, pp. 49–50.

[b] Mr. Kenning became acquainted with Grimm alfalfa at a very early date—1863 or 1864—and although he gives Mr. Grimm credit for developing it into a hardy strain, he does not believe that Grimm was the actual introducer. His recollections, as given in a recent letter to the writer, follow:

"From 1861 to 1864 I was employed in teaming, hauling wood mostly from a settlement of Swiss in the eastern part of Laketown, 6 miles north of Chaska, Carver County. During that time, I should judge in 1863, a family, relatives of one of the Swiss colony, immigrated to Minnesota, settling in the colony, bringing various kinds of seed from their native country, and among them alfalfa seed, or, as they called it, 'ewiger Klee,' meaning everlasting clover. What called my attention to this was the

At the 1903 meeting of the Minnesota State Agricultural Society, Kenning first told of his memory that Grimm's early attempts met with discouraging results and also stated his belief that the original seed was brought in by Swiss immigrants.[a] In 1904 Mr. Kenning again called attention to the matter in a letter published in the issue of March 1 of Farm, Stock, and Home (vol. 20, p. 112), stating: "For many years it [Grimm alfalfa] made but little headway and was too often a failure, but by persisting in saving every plant that could be saved it gained strength and seemed to acclimate, or possibly produced a new variety, until it is one of the surest clovers for that section [Carver County]."

The testimony of Mr. Grimm's immediate family and that of his old friends and neighbors who were in a position to know the facts leaves little room to doubt that he was the introducer, as well as the unconscious breeder, of the valuable alfalfa that bears his name.[b] From

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discussion and ridicule that was brought forth by the idea of growing clover in this frozen region. There was but one man, Wendelin Grimm, a native of Baden, Germany, who had the courage to give it a trial. He got a portion of the seed, which he sowed, the balance being sown by one of the Swiss. We had a rather hard winter, mostly killing out the plants, but the few that survived were carefully nursed by Mr. Grimm. As it was a good year for seed, Mr. Grimm got enough to sow a small patch the following year. This either proved more hardy or the season was more favorable and produced a good quantity of seed; it began also to interest others, who gave it a trial. In 1868 or 1869 I was present at a gathering of farmers at the brewery on the outskirts of Chaska. Among them was Mr. Grimm, and he was entertaining the farmers with a history of his success with this clover, which deeply interested all."

Many accounts have been circulated from time to time as to the origin of Grimm alfalfa, one seed firm even claiming to have furnished Mr. Grimm his original seed as late as 1892, although he died in 1891. Most of these accounts have been investigated and only Mr. Kenning's appears to deserve comment, as he knew Grimm personally and was familiar with his alfalfa for many years.

[a] Annual Report Minnesota State Agricultural Society, 1903, p. 40.

[b] In a letter dated Feb. 7, 1910, Mr. Kenning states that Mr. Gottlieb Plocher, of Victoria, Minn., who was a near neighbor and friend of Mr. Grimm, was very familiar with the origin of the latter's lucern seed and had grown it from the beginning. Mr. Plocher came to Minnesota from Germany in 1855, and knew Mr. Grimm from the time of his arrival in 1857 until he died in 1891. The following statement, in free translation, is taken from a German letter recently received from Mr. Plocher: "To my positive knowledge Grimm brought with him from Germany [Baden] a packet of 'ewiger Klee,' as he called it, and as it is still called to-day by many Germans. * * * As he was packing up at his old home before he emigrated he was in doubt as to whether or not he should take along the packet in question, as he was very short of space. Finally he decided to take it with him."

As long ago as 1872 or 1873 Tobias Ottinger, another of Grimm's neighbors, told Mr. Kenning that Mr. Grimm had brought the seed in with him. The accounts of Frank Grimm, the younger son, who still lives in Carver County, Minn., and of Joseph, the elder son, who lives in Florida, coincide exactly. The latter left Minnesota in 1876 and has been back only once in the interim, and that twenty-six years ago.

the very nature of the testimony at this late date there is abundant opportunity for different men to reach different conclusions.

Mr. George Du Toit, who in the early day sold Mr. Grimm many of his field and garden seeds, and later was president of the bank at which Mr. Grimm transacted business, tells of one particular spring, about 1875, that the latter stopped him as he was driving by his farm and told him of the killing out of his lucern. So badly had it fared during the preceding winter that Grimm felt himself extremely fortunate to have saved a small bag of seed of a previous year's growth, which he had hanging in the granary and which he showed to Mr. Du Toit.

Investigation of the weather records of Minnesota corroborates Mr. Du Toit's memory statement with regard to the severity of the winter of 1874–5. Its mean temperature was 3.7° F., the lowest mean recorded at St. Paul since 1854. Considering the comparative mildness of the climate whence Grimm brought his seed, there is little wonder that the selective effect of this particular winter was so disastrous, though other severe winters had intervened in Minnesota between 1858, the first seeding year of Grimm alfalfa, and 1875. Grimm's persistence and the evident value of the forage that he grew gradually led his neighbors into the culture of alfalfa.[a]

In 1865 the elder Grimm purchased a thrashing machine from an implement dealer, who advised him to produce as much alfalfa seed as possible and offered to sell all that he could raise. Joseph, who managed this thrashing machine for seven years, states that in 1867 his father produced 480 pounds of seed on 3 acres of land, which he thrashed with the machine and sold in Minneapolis for 50 cents a pound. This appears to be the first considerable quantity of seed ever produced and it is a matter of regret that it was sold out of the neighborhood.

From 1871 until 1890 gradual progress was made in the extension of alfalfa in Carver County. By this time the common alfalfa of Utah, New Mexico, and California had begun to attract considerable attention throughout the country, and much common alfalfa was tried in Minnesota.

In not infrequent years fair crops of seed were produced, but owing to the small demand the seed did not find ready sale, and it was commonly delivered to the local store in barter for household necessities. By the time of Mr. Grimm's death, in 1891, this condition had disappeared, and gradually most of his surplus seed went into the hands of neighbors and less to the local stores. Since 1890 much common alfalfa from Utah, Kansas, and California and imported seed obtained from the larger seed houses has been tested in this section, but there is no record of even one permanently successful effort with these strains of seed.

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[a] Up to 1871 the extension of this alfalfa was very slow. This is explained by Joseph Grimm as being due to the fact that hitherto no law had existed which prevented the ranging of stock on vacant lands. In that year the Minnesota legislature passed a local stock law in accordance with whose provisions every township could vote to keep stock from running at large. According to Joseph, prior to 1865 practically no clover or alfalfa seed was planted in their neighborhood, as the cattle had plenty of open range to feed upon and the farmers needed their land for other crops.

Still, there was no general recognition that the Grimm strain was more valuable than others, cultural treatment and other extraneous explanations being given as to the cause of failure in the growth of the ordinary kind. Grimm's own son-in-law some years later, when his brother wrote him for alfalfa seed, not having produced any himself that he could furnish, bought two bushels of the ordinary kind at the local store and sent it to him.

In 1899, with the exception of certain counties in New York, Carver was the only county east of the Mississippi and Missouri Rivers that reported as much as 1,000 acres of alfalfa under cultivation. By this time the reputation of Grimm's alfalfa began to be a little more than local, though its real value was not yet realized. In 1900, Mr. A. B. Lyman,[a] a Carver County farmer, whose farm is only a few miles distant from the Grimm farm, called the attention of Prof. Willet M. Hays, Assistant Secretary of Agriculture, who was at that time professor of agriculture in the University of Minnesota, to this strain of alfalfa and to his experience with it and with the ordinary kind. Professor Hays quickly recognized the probable value of the Grimm strain and made immediate efforts to extend its culture.

Mr. Lyman first saw the Grimm alfalfa in 1881, when, as a boy, he accompanied his father about the county. Later, in 1890, he taught school in a section of Carver County where practically all of the German farmers were growing alfalfa, which they called "ewiger Klee" (everlasting clover). Returning home at the close of his school term in spring he told of the great advantages of growing alfalfa. Accordingly, a quantity of commercial seed was purchased and sown on the home farm. The first season's growth was fine and the new seeding passed the first winter successfully. This is frequently the case, especially when seeded with grain, as the stubble holds sufficient snow to give the young plants protection. The hay yield of the second summer (the first crop year) was good, but during the following winter the alfalfa all killed out. Lyman observed that the fields of the German farmers had not done likewise, and in 1894, in renewing his efforts to grow alfalfa, he used seed grown by them. The results of his new trial were entirely successful; ever since that time he has had Grimm alfalfa growing on his farm continuously. At one time as many as 100 of his 250 acres were devoted to the crop.

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[a] An account of Mr. Lyman's attempts to propagate seed of Grimm's alfalfa can be found in the annual report of the Minnesota State Agricultural Society for 1903, pp. 38–44.

RECENT EXPERIENCES WITH GRIMM ALFALFA.

Recognition of the superiority of the Grimm variety over ordinary alfalfa by Mr. Lyman, and through him by Professor Hays, of the Minnesota station, marked a third era in the evolution of alfalfa culture in the Northwest. About this time Turkestan alfalfa, some strains of which have proved considerably hardier than common alfalfa, began to attract attention and probably somewhat retarded the development of a Grimm alfalfa industry. In 1901 experiments were begun with the Grimm variety on the Minnesota University farm, which attracted added attention to it. In a short paper published in 1904 Professor Hays[a] gave its history as then understood and predicted in a measure its potential value.

The reputation already acquired and the favorable mention accorded it from time to time in the agricultural papers of the Northwest and elsewhere immediately created such a demand for the seed that only a small fraction of it could be satisfied. The Minnesota climate, except in occasional years, is quite unfavorable for seed production, hence the available supply of seed has always been small. This condition has led to adulteration with seed of inferior strains in some cases and to the recommendation of substitutes in still others.

In 1904 the attention of the Department of Agriculture was directed to Grimm alfalfa and experiments with it were begun in 1905. The first lot of seed obtained by the department was received by the writer from Prof. J. H. Shepperd, of the North Dakota Agricultural Experiment Station, in October, 1904. Since that time it has been grown in comparison with a very large number of regional varieties, representing practically all of the more important alfalfa-producing regions of the world. Some of the results of these experiments are briefly given here. So far as known there is no case of record where the comparison was a fair one in which the hardiness of Grimm alfalfa has been exceeded by any other.

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[a] Hays, W. M. Hardy Alfalfa in Minnesota. Press Bulletin 21, Minnesota Agricultural Experiment Station, March, 1904.

EXPERIMENTS OF INVESTIGATORS.

EXPERIMENTS AT ST. ANTHONY PARK, MINN.

Comparison of varieties.—The Agricultural Experiment Station of the University of Minnesota was the first to compare Grimm alfalfa with other kinds. This work was begun in 1901 under the direction of Prof. Willet M. Hays, whose excellent statistical methods have been followed in all the experiments. His press bulletin on the subject is referred to above. The results as to winterkilling presented below for the first time were furnished by Mr. A. C. Arny, of the station staff, through the courtesy of Dr. A. F. Woods, dean and director, and Prof. Andrew Boss, professor of agriculture in the University of Minnesota and agriculturist to the experiment station. The writer desires to acknowledge the energetic and efficient cooperation and assistance given by the Minnesota station through its various officers.

The severe winter conditions that prevail in the vicinity of Minneapolis and St. Paul, where the longest series of experiments with Grimm alfalfa has been carried on, have already been touched upon in a general way. The weather of individual winters during the progress of the work will be discussed briefly in their relation to the results obtained.

Experiments begun in the spring of 1901.—The first experiments for which data are available were begun in the spring of 1901. The following table shows the comparative behavior of the four alfalfas tested:

TABLE III.—*Winterkilling of alfalfa in experiments begun in 1901 at St. Anthony Park, Minn.*

Minnesota No.	Source of seed.	Number of plants alive—		Percentage of winter loss.
		Autumn of 1901.	Spring of 1902.	
4	Carver County, Minn., Grimm (grown by A. B. Lyman)	54	52	3.7
5	Commercial seed	79	50	36.7
6	do	50	22	56.0
7	Iowa seed	65	55	15.4

The average loss of the three samples compared with the Grimm was 36 per cent. The loss of the Grimm was 3.7 per cent.

The winter of 1901–2 at Minneapolis was of average severity. The lowest temperature recorded was −27° F. The mean for the winter months (December, January, and February) was 17.6° F., while the mean of the minima for the same months was 9.6° F.

The following tabulation is designed to give the data as to temperature which have a direct bearing on studies of cold resistance:

Table IV.—*Temperatures at Minneapolis, Minn., November, 1901, to March, 1902, inclusive.*

Period.	Mean.	Mean of the minima.	Lowest temperature.	Days with minima below zero.
	°F.	*°F.*	*°F.*	*Number.*
November, 1901	31.0	22.4	12	0
December, 1901	15.9	8.5	−27	8
January, 1902	18.7	10.2	−17	7
February, 1902	18.2	10.1	−15	7
March, 1902	36.2	27.2	− 7	2
For the 5 months	24.0	15.7	−27	24
For December, January, and February	17.6	9.6	−27	22

The following brief summary shows the conditions that prevailed with reference to precipitation from the spring of 1901, when seeding was done, until the spring of 1902, when the determinations of winterkilling were made:

Table V.—*Precipitation at Minneapolis, Minn., April, 1901, to March, 1902.*

Period.	Precipitation.	
	Form.	Inches.
April to August, 1901	Rain	14.37
September to November, 1901	do	7.32
December, 1901, to March, 1902	do	.57
November, 1901, to March, 1902	Snow	19.90
Total for the entire period		24.25

The total rainfall of the growing season for this year was the lowest experienced during the years included in these experiments, 1901 to 1909. The total snowfall was also the lowest for the period.

Experiments begun in the spring of 1902.—In the spring of 1902 a varying number of hills, ranging from 94 hills in a supposed Grimm sample of unknown source to 6,298 hills in a sample known to be Grimm, was planted. Included among the 11 kinds were 5 strains of Grimm, 2 strains of Turkestan, and 4 samples of commercial seed of ordinary alfalfa. Three of the samples of commercial seed were produced in the 1901 experiments shown in Table III. Unfortunately the number of hills living in the fall of 1902 was not determined. A comparison of the total number of hills planted in the spring of 1902 with the number of hills alive in the spring of 1903 shows an average loss of 30.2 per cent for the 5 Grimm samples. The average for the 6 other samples was 43.4 per cent. Only a portion of the loss in these cases can be attributed to winterkilling. Table XI shows that the number of hills planted in spring is a very poor index of the number of hills alive in autumn.

The winter of 1902–3 was about 2 degrees colder than the normal for Minneapolis for a number of years. The lowest temperature recorded was –24° F., while the mean for the winter months was 15° F. The mean of the minima for the same months was 6.4° F. The following are the most important features of the weather during the winter of 1902–3:

TABLE VI.—*Temperatures at Minneapolis, Minn., November, 1902, to March, 1903.*

Period.	Mean.	Mean of the minima.	Lowest temperatures.	Days with minima below zero.
	° F.	*° F.*	*° F.*	*Number.*
November, 1902	36.0	30.6	17	0
December, 1902	15.6	8.1	–20	7
January, 1903	14.6	5.5	–14	11
February, 1903	14.8	5.6	–24	9
March, 1903	33.6	26.6	8	0
For the 5 months	22.9	15.3	–24	27
For December, January, and February	15.0	6.4	–24	27

It will be seen that the means of the minima for the winter months are rather low.

With reference to precipitation the following conditions prevailed from the spring of 1902 until the spring of 1903, when the number of living hills was determined, as shown in column 3 of Table VIII.

TABLE VII.—*Precipitation at Minneapolis, Minn., April, 1902, to March, 1903.*

Period.	Precipitation.	
	Form.	Inches.
April to August, 1902	Rain	20.59
September to November, 1902	do	6.71
December, 1902, to March, 1903	do	3.14
November, 1902, to March, 1903	Snow	27.40
Total for the entire period		33.18

This experiment was carried through a second season. The total loss suffered from all causes between the spring of 1903 and the spring of 1904 is shown in Table VIII.

TABLE VIII.—*Loss of alfalfa hills during 1903 and 1904 in experiments begun in 1902 at St. Anthony Park, Minn.*

Minnesota No.	Source of seed.	Number of hills alive in spring of—		Percentage of loss 1903 and 1904.[a]
		1903.	1904.	
2	Turkestan Tashkend, S. P. I., No. 991	184	10	94.7
4a	Grimm from 1901 planting (Table III, No. 4) [b]	285	116	59.4
5a	Commercial seed from 1901 planting (Table III, No. 5)	441	11	97.5
6a	Commercial seed from 1901 planting (Table III, No. 6)	241	6	97.5
7a	Iowa seed from 1901 planting (Table III, No. 7)	139	5	96.4
11	Turkestan grown at Brookings, S. Dak., from S. P. I., No. 991	131	20	84.8
12	Variety unknown (Wayzata, Minn.)	270	65	75.9
13	Carver County, Minn., Grimm (grown by A. B. Lyman, 1901)	4,534	4,035	11.0
14	Carver County, Minn., Grimm (grown by A. B. Lyman, 1900)	1,472	1,249	15.2
15	do	1,332	1,056	20.7
16	Source unknown (supposed to be Grimm)	51	48	5.9
	SUMMARY (AVERAGE LOSSES).			
4a, 13, 14, 15	Grimm, 4 strains	7,623	6,456	26.5
2, 11	Turkestan, 2 strains	315	30	89.7
5a, 6a, 7a, 12	Commercial, 4 strains	1,091	87	91.8
16	Source unknown, 1 strain	51	48	5.9

[a] The plants were not counted in the autumns of 1902 and 1903, hence the percentage of loss given in column 5 represents loss due to all causes.

[b] The letters *a*, *b*, *c*, *d*, etc., affixed to certain numbers in this and other tables represent the successive seed generations through which the parent strain has passed.

The winter of 1903–4 was considerably more severe here than the normal winter, as may be seen by a comparison of the data given below with those given for St. Paul in Table I. The mean for the three winter months was 8.3° F., while the mean of the minima for the same number of months was 0.4° F. The total number of days having a minimum below zero was 42.

TABLE IX.—*Temperatures at Minneapolis, Minn., November, 1903, to March, 1904.*

Period.	Mean	Mean of the minima.	Lowest temperature.	Days with minima below zero.
	° F.	*° F.*	*° F.*	*Number.*
November, 1903	29.8	22.2	0	0
December, 1903	12.6	3.8	−19	12
January, 1904	7.3	.1	−33	12
February, 1904	5.1	−2.6	−19	17
March, 1904	27.7	21.0	− 4	1
For the 5 months	16.5	8.9	−33	42
For December, January, and February	8.3	.4	−33	41

The following conditions prevailed as to precipitation during the period from April, 1903, to March, 1904:

TABLE X.—*Precipitation at Minneapolis, Minn., April, 1903, to March, 1904.*

Period.	Precipitation.	
	Form.	Inches.
April to August, 1903	Rain	20.41
September to November, 1903	do	13.31
December, 1903, to March, 1904	do	.75
November, 1903, to March, 1904	Snow	31.50
Total for the entire period		37.62

As previously noted, the Grimm strains lost 26.5 per cent, the Turkestan and commercial varieties 91.1 per cent, and No. 16, the source of which is unknown, 5.9 per cent. It is the writer's belief that the excess of autumn moisture was a very important factor in winterkilling in this experiment.[a]

The percentage of loss in Grimm No. 4*a*, compared with its parent No. 4, as shown in Table III, suggests interesting and important possibilities. It will be noted that the original Grimm seed No. 4 killed out only 3.7 per cent, while its progeny 4*a* killed out 59.4 per cent. No. 4*a* was produced alongside of 3 nonhardy strains of ordinary alfalfa, which fact appears to have brought about a very notable deterioration in hardiness, due to cross-fertilization. As collateral evidence that this is really the case it will be noted that in Table VIII 3 uncontaminated strains of Grimm (Nos. 13, 14, and 15) and another hardy sample, No. 16, obtained at about the same time, suffered an average loss of only 13.2 per cent. Similar results have been observed in other experiments; hence, it is essential that growers of hardy alfalfa should keep their seed plats well isolated from fields of any nonhardy kinds in order to guard against cross-fertilization or mixing.

Experiments begun in the spring of 1905.—In the spring of 1905 another experiment, including 5 Grimms, 3 Turkestans, and 6 strains from ordinary commercial seed was begun. As in the experiments previously described the plants were set out in hills, the number of hills of each kind varying greatly. Table XI shows winterkilling for the winter of 1905–6 and total loss from 1906 to 1907.

One important point should be remembered in connection with the Grimm samples included in this experiment. All had been produced in previous experiments where they were grown alongside other hardy strains. Hybridization undoubtedly took place and it is quite likely that deterioration resulted. Unfortunately no pure Grimm strain was included in this experiment as in the experiment begun in 1902. (See Table VIII.)

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[a] Readers desiring a fuller discussion of the injurious effects of autumn moisture should consult Bulletin 185, Bureau of Plant Industry.

The surviving plants of the experiment begun in the spring of 1905 were left to endure the winter of 1906–7. The character of winter weather experienced by these survivors is discussed in connection with Table XIV. Regarding the loss suffered from the time of counting in the spring of 1906 until recounts were made in the spring of 1907, as shown in Table XI, it may be said that 718 Grimm plants were living in the spring of 1906, and 595 of the same Grimm plants were living in the spring of 1907. Only 39 hills of the varieties other than Grimm came through alive in the spring of 1906; 30 of these were still living in the spring of 1907.

TABLE XI.—*Winterkilling of alfalfas in experiments begun in 1905 at St. Anthony Park, Minn.*

Minnesota No.	Source of seed.	Hills planted in spring of 1905.	Hills alive in fall of 1905.	Hills alive in spring of 1906.	Winter loss, 1905–6.	Hills alive in spring of 1907.	Total loss, 1906–7.[a]
		Number.	*Number.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*
4*b*	Grimm from 1902 planting (Table VIII, No. 4*a*)	386	346	88	74.6	75	14.8
5*b*	Commercial from 1902 planting (Table VIII, No. 5*a*)	62	58	8	86.2	7	12.5
13*a*	Grimm from 1902 planting (Table VIII, No. 13)	2,132	1,930	362	81.3	280	22.6
14*a*	Grimm from 1902 planting (Table VIII, No. 14)	1,328	1,229	183	85.2	171	6.6
15*a*	Grimm from 1902 planting (Table VIII, No. 15)	650	612	85	86.1	69	18.8
16*a*	Seed from 1902 planting (Table VIII, No. 16, original source unknown)	192	186	27	85.5	21	22.2
34	Commercial Turkestan	310	230	2	99.2	2	0.0
35	Montana	310	259	1	99.6	0	100.0
36	Utah	306	90	1	98.9	0	100.0
37	Colorado	396	227	0	100.0	....	....
38	Nebraska	272	201	0	100.0	....	....
1*a*	Turkestan grown at the Minnesota station from S. P. I. No. 991 (Minn. No. 1), received in 1898	120	100	0	100.0	....	....
2*a*	Turkestan grown at the Minnesota station from S. P. I. No. 991 (Minn. No. 2), received in 1900 (Table VIII, No. 2)	120	97	0	100.0	....	....
3	Commercial seed	120	115	0	100.0	....	....
	SUMMARY (AVERAGE LOSSES).						
4*b*, 13*a*, 14*a*, 15*a*	Grimm, 4 strains	4,496	4,117	718	81.8	595	15.7
5*b*, 16*a*, 34–38, 1*a*, 2*a*, 3	Other than Grimm, 10 strains	2,118	1,563	39	96.9	30	23.0
5*b*, 35–38, 3	Ordinary (other than Grimm), 6 strains	1,926	950	10	97.4	7	33.3
34, 1*a*, 2*a*	Turkestan, 3 strains	1,376	427	2	99.7	2	0.0

[a] As plants were not counted in the autumn of 1906, figures in last column include loss from all causes between the spring of 1906 and the spring of 1907.

Grimm alfalfa entered the winter of 1905–6 with 4,117 hills, of which 718 emerged alive in the spring of 1906. Strains other than Grimm entered the winter of 1905–6 with 1,563 hills, of which only

39 hills emerged alive in the spring of 1906. This shows well the great rigor of the test. So far as the writer knows this is the severest loss which Grimm alfalfa ever suffered in any experiment.

The winter of 1905–6 was not an exceedingly severe one, though winter temperatures continued from November until nearly March 25. Temperatures below zero occurred in every month from November to March, inclusive. Nevertheless, the mean for these months as well as the mean for the strictly winter months was rather higher than normal. The lowest temperature experienced was $-17°$ F., and there were twenty-five days with minima below zero. It is evident from this that some other cause than mere cold must be sought to explain the extensive winterkilling in all varieties.

The conditions as to precipitation that prevailed from the spring of 1905, when planting was done, until the spring of 1906, when the determinations of winterkilling were made, were as follows:

Table XII.—*Precipitation at Minneapolis, Minn., April, 1905, to March, 1906.*

Period.	Precipitation.	
	Form.	Inches.
April, 1905, to August, 1905	Rain	19.45
September, 1905, to November, 1905	do	8.44
December, 1905, to March, 1906	do	.58
November, 1905, to March, 1906	Snow	26.20
Total for the entire period		31.09

It is believed that two rather unusual factors were concerned in the losses observed. First, and perhaps the more important, was the large quantity of autumn rain, especially as almost 2½ inches fell during November, the greater part of it in the last decade of the month. Immediately following the last rain a minimum of $-8°$ F. was recorded with no snow on the ground. December was practically a snowless month, only 0.4 of an inch falling. This condition, combined with a period of thawing during the latter part of February and another during the early part of March, probably explains the excessive winter losses in all varieties.

Observations that have been made indicate that losses in the case of excessive autumn moisture are due to three causes: (1) Failure of the plants to become dormant early enough; (2) actual rotting of the crowns if rainfall occurs after growth has stopped; (3) rupture or breaking of the roots, due to heaving of the ground.

With reference to alternate thawing and freezing, it may be said that the spring of 1902, when the 4 varieties shown in Table III suffered a comparatively moderate loss, was much more trying than a similar condition which prevailed in the spring of 1906.

In February, 1902, there were nine days with thawing temperatures, the maximum recorded being 54° F. Then followed a week of colder weather with a minimum of 10° F. Beginning on March 4 a period of twelve days of thawing weather with a maximum of 62° F. was followed immediately by two days with minima below zero.

In contrast, February, 1906, had seven days of thawing weather extending from the 18th to the 24th, the maximum recorded being 47° F. Then followed ten days of colder weather, three with slight thawing, the minimum recorded during the time being 6° F. In five days of thawing weather, March 5 to 9, the maximum recorded was 44° F. On the 11th a minimum of −6° F. occurred and cold weather continued until about the 24th, when the winter began to break up.

Snowfall during both February and March, 1906, was light. The minimum temperature for the winter (−17° F.) occurred February 10, when there was no snow on the ground and before the alternate thawing and freezing mentioned above. The most important features of the winter of 1905–6 as to temperatures are shown in the following tabulation:

TABLE XIII.—*Temperatures at Minneapolis, Minn., November, 1905, to March, 1906.*

Periods.	Mean.	Mean of the minima.	Lowest temperature.	Days with minima below zero.
	° F.	*° F.*	*° F.*	*Number.*
November, 1905	35.2	27.2	−8	2
December, 1905	23.9	16.8	−1	1
January, 1906	20.0	12.1	−8	7
February, 1906	16.2	6.9	−17	11
March, 1906	22.4	15.3	−6	4
For the 5 months	23.5	15.6	−17	25
For December, January, and February	20.0	11.93	−17	19

Experiments begun in the spring of 1906.—A collection of 15 strains of alfalfa was planted in hills in the spring of 1906; 4 Grimms, 3 Turkestans, 7 strains of ordinary alfalfa, and No. 16*b*, were included in the test. The seed used in the case of 13*b* to 16*b* (Table XIV) was grown from the 1905 plantings of these strains. Inasmuch as the plats from which the seed was taken were seeded in the spring of 1905, the seed used in 1906 must have been collected in the autumn from hills less than a year old. This gave a wide opportunity for crossing between hardy and nonhardy strains, without the intervention of a winter to eliminate the less hardy hybrids. The winterkilling that took place between the fall of 1906 and the spring of 1907 is shown in Table XIV.

Table XIV.—*Winterkilling of alfalfas in experiments begun in 1906 at St. Anthony Park, Minn.*

Minnesota No.	Source of seed.	Hills planted in spring of 1906.	Number of plants alive in—		Percentage of winter loss.
			Fall of 1906.	Spring of 1907.	
13*b*	Grimm, from 1905 planting (Table VIII, No. 13, and Table XI, No. 13*a*)	310	217	194	10.6
14*b*	Grimm, from 1905 planting (Table VIII, No. 14, and Table XI, No. 14*a*)	188	118	100	15.3
15*b*	Grimm, from 1905 planting (Table VIII, No. 15, and Table XI, No. 15*a*)	62	38	33	13.2
16*b*	Variety unknown; seed from 1905 planting (Table VIII, No. 16, and Table XI, No. 16*a*)	30	16	15	6.3
34	Montana, from original seed (Table XI)	256	193	28	85.5
36	Utah, from original seed (Table XI)	240	163	1	99.4
37	Colorado, from original seed (Table XI)	256	221	27	87.8
38	Nebraska, from original seed (Table XI)	240	167	11	93.4
1*b*	Home-grown Turkestan seed produced on station farm from S. P. I. No. 991 (Table XI, Nos. 1*a* and 2*b*)	240	150	63	58.0
2*b*	Home-grown Turkestan seed produced on station farm from S. P. I. No. 991 (Table VIII, No. 2, and Table XI, No. 2*a*)	256	233	133	42.9
3	Grown from commercial alfalfa, Minnesota No. 3 (Table XI, No. 3)	240	174	25	86.2
71	Ogden, Utah	256	242	28	88.4
72	Billings, Mont. (S. P. I. 12747)	240	188	9	95.3
73	Grimm, mixed seed from 1905 planting (Table XI)	256	201	128	36.3
75	Commercial Turkestan	1,488	1,226	1,116	8.9
	SUMMARY (AVERAGE LOSSES).				
13*b*, 14*b*, 15*b*, 73	Grimm, 4 strains	816	574	455	18.8
1*b*, 2*b*, 75	Turkestan, 3 strains	1,984	1,609	1,312	36.6
34–38, 3, 71, 72	Ordinary, 7 strains	1,728	1,348	129	90.8

The winter of 1906–7 was about normal in severity, as the following statement shows:

Table XV.—*Temperatures at Minneapolis, Minn., November, 1906, to March, 1907.*

Period.	Mean.	Mean of the minima.	Lowest temperature.	Days with minima below zero.
	° F.	*° F.*	*° F.*	*Number.*
November, 1906	33.6	27.7	10	0
December, 1906	20.1	12.7	−12	4
January, 1907	7.4	− .7	−18	16
February, 1907	17.5	8.3	−22	8
March, 1907	31.4	22.7	5	0
For the 5 months	22.0	14.14	−22	28
For December, January, and February	15.0	6.8	−22	28

The mean temperature for January was about 5 degrees below normal.

The following conditions as to precipitation prevailed from the spring of 1906 to the spring of 1907:

TABLE XVI.—*Precipitation at Minneapolis, Minn., April, 1906, to March, 1907.*

Period.	Precipitation.	
	Form.	Inches.
April to August, 1906	Rain	21.58
September to November, 1906	..do	8.19
December, 1906, to March, 1907	..do	.26
November, 1906, to March, 1907	Snow	28.70
Total for the entire period		32.90

A comparison of Tables XIII and XV shows that the winter of 1905–6 was milder than that of 1906–7; but in spite of this fact winterkilling was far more extensive. The mean temperature for the coldest month during the winter of 1905–6 (February) was 16.2° F. The mean for the coldest month in the winter of 1906–7 (January) was 7.4° F.

It seems likely that temperature and moisture conditions in November, 1906, have an important bearing on the reduced extent of winterkilling as shown in Table XIV as compared with Table XI. In November, 1905, the temperatures ranged rather high until within five days of the end of the month. This no doubt tended to keep the plants in a growing condition. Immediately following came three very cold days, the thermometer going to −2° F. on the 29th and to −8° F. on the 30th. In contrast November, 1906, grew cold gradually, this tending to produce dormancy without injury to the plants. The lowest temperature experienced during the month was 20° F., which occurred before the middle of the month. December, 1906, had 6½ inches of snow, while December, 1905, was practically snowless.

Experiments begun in the spring of 1907.—A new experiment, including 16 different samples, was begun in the spring of 1907. These samples included 7 of Grimm, 3 of ordinary alfalfa, and 6 selected strains. The selected strains included 3 selections made by Prof. W. A. Wheeler from Turkestan, S. P. I. No. 991 (South Dakota No. 164), another sample selected from the same S. P. I. number but distributed as South Dakota No. 240, and also a selection by Professor Wheeler from South Dakota No. 167, the so-called Baltic alfalfa.[a] The loss suffered by these strains during the winter of 1907–8 can not be told, as the hills were not counted in the autumn of 1907.

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[a] For additional discussion of this strain, see Bulletin 185, Bureau of Plant Industry.

The temperature conditions that prevailed during the winter of 1907–8 are shown in the following tabulation:

TABLE XVII.—*Temperatures at Minneapolis, Minn., November, 1907, to March, 1908.*

Period.	Mean.	Mean of the minima.	Lowest temperature.	Days with minima below zero.
	° F.	*° F.*	*° F.*	*Number.*
November, 1907	34.6	27.8	11	0
December, 1907	25.0	17.1	− 2	1
January, 1908	19.8	9.8	−25	6
February, 1908	21.4	14.3	− 8	3
March, 1908	29.3	21.1	− 4	1
For the 5 months	26.0	18.0	−25	11
For December, January, and February	22.0	13.73	−25	10

The winter as a whole was several degrees warmer than normal, and the number of days with temperatures below zero decidedly less than the average. Conditions with respect to precipitation from April, 1907, to March, 1908, were as follows:

TABLE XVIII.—*Precipitation at Minneapolis, Minn., April, 1907, to March, 1908.*

Period.	Precipitation.	
	Form.	Inches.
April to August, 1907	Rain	15.89
September to November, 1907	do	4.49
December, 1907, to March, 1908	do	.35
November, 1907, to March, 1908	Snow	27.50
Total for the entire period		23.48

It may be stated that the autumn rainfall of 1907 was the lowest of any year during the period covered by these experiments, amounting to only 4.49 inches. All of the fall months had less than their normal amount of precipitation. The winter snowfall was normal.

In view of the character of the weather that prevailed, it is interesting to note that the average loss from all causes found by comparing the number of plants alive in the spring of 1908 with the number of hills planted in the spring of 1907 (not shown in Table XIX) was 6.6 per cent for the 7 Grimm samples and only 10.5 per cent for the 9 other samples.

The total loss, as determined by counting the plants alive in the spring of 1908 and in the spring of 1909, is shown in Table XIX.

TABLE XIX.—*Loss of alfalfas in experiments begun in 1907 at St. Anthony Park, Minn.*

Minnesota No.	Source of seed.	Number of plants alive in spring of—		Percentage of loss.[a]
		1908.	1909.	
4c	Grimm seed from 1905 planting (Table XI, No. 4b)	56	55	1.8
13c	Grimm seed from 1905 planting (Table XI, No. 13a)	96	92	4.2
14c	Grimm seed from 1905 planting (Table XI, No. 14a)	33	33	0.0
15c	Grimm seed from 1905 planting (Table XI, No. 15a)	70	62	11.4
81–95	Grimm; bulked seed selections by Wheeler in South Dakota from South Dakota No. 162	282	247	12.4
76	Commercial seed said to have been northern grown	50	8	84.0
77	Utah Dryland	51	14	72.6
78	Grimm, from Carver County, Minn., grown by Mr. Trieloff	250	250	0.0
79	South Dakota No. 167; Wheeler's selection from the so-called Baltic alfalfa	238	215	9.7
80	South Dakota No. 240; Wheeler's Highmore selections from Turkestan S. P. I. No. 991	251	243	3.2
96	South Dakota No. 164; selections by Wheeler made at Brookings and Highmore from Turkestan S. P. I. No. 991	24	24	0.0
97	South Dakota No. 164; selections by Wheeler made at Brookings and Highmore from Turkestan S. P. I. No. 991	16	14	12.5
98	South Dakota No. 164; selections by Wheeler made at Brookings and Highmore from Turkestan S. P. I. No. 991	23	22	4.4
99	Grimm seed produced in 1906 from 1905 planting	228	221	3.1
100	Seed from 1906 planting; probably Grimm	253	240	5.1
102	Billings, Mont., S. P. I. No. 12747	260	8	97.0
	SUMMARY (AVERAGE LOSSES).			
4c, 13c, 14c, 15c, 81–95, 78, 99	Grimm, 7 strains	1,015	960	4.7
79, 80, 96–98, 100	Selected by Wheeler, 6 strains	805	758	5.8
76, 77, 102	Ordinary, 3 strains	361	30	84.5

[a] Through an oversight counts of living plants were not made in the autumns of 1907 and 1908; hence, the percentages given in "Percentage of loss" column include losses due to all causes.

In this experiment were what may be truly termed the hardiest of all known cultivated alfalfas, including the Grimm, Wheeler's so-called Baltic alfalfa, and the hardy strains of acclimatized Turkestan alfalfa selected by Wheeler at Highmore and Brookings, S. Dak., presumably from Hansen's original importation, S. P. I. No. 991,[a] which came from the cotton-growing sections of Turkestan.

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[a] There is little room for doubt that South Dakota No. 240 is the progeny of S. P. I. No. 991. With reference to South Dakota No. 164, its origin is not so well established, as the early records were somewhat faulty. This uncertainty should be borne in mind, but it does not necessarily interfere with the value of the results obtained.

The following statement concerning No. 991 occurs on page 81 of Inventory No. 1, Section of Seed and Plant Introduction:

> **991.** MEDICAGO SATIVA. **Alfalfa.**
>
> From Tashkend. Received through Prof. N. E. Hansen, June 4, 1898. (200 bushels.)
>
> Variety "turkestanica." *This subspecies of alfalfa was obtained from eight different sources varying widely in climatic conditions.* It endures droughts which kill European alfalfa. Deemed very promising for trial in droughty reigons. See No. 469.

The italicized portion of this statement has been interpreted to mean that 991 is a blanket number for eight different lots of seed from various parts of Turkestan. A

Of the 1,268 Grimm plants (including No. 100, which is probably Grimm) alive in the spring of 1908, 1,200 came through alive in the spring of 1909. Of 552 plants of the hardy acclimatized strains[a]

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careful study of the records clearly indicates that this interpretation, which has resulted in much uncertainty and confusion, is probably incorrect, and that the eight different sources alluded to in the note are represented by S. P. I. Nos. 469, 991, 999, 1101, 1150, 1151, 1159, and 1169. In the inventory the name "turkestanica," which has no botanical significance, is applied to each one of these eight numbers either directly or by reference.

From an examination of the records it is apparent furthermore that at least a part of the 200-bushel lot to which 991 was assigned was received as early as March, 1898. In a letter dated March 31, Prof. N. E. Hansen says: "By the way, the Turkestan alfalfa we received here came without any label as to locality. It is important that all these 10-pound lots that are sent out be labeled with the locality from which they came. The first lot as numbered are all from Samarkand." As bearing on the question as to whether or not 991 is a blanket number, Professor Hansen in a letter dated May 20, 1898, says:

"We would like very much to have a sample of each of the eight kinds of alfalfa sent for the small plats in the botanical and agricultural plats here—forage plant tests—[including] the Bokhara alfalfa just received [No. 679] and the Samarkand lot [no doubt a part of No. 991] received some time ago."

[a] The high degree of acclimatization to which alfalfa is susceptible appears to be well shown by experience with Turkestan No. 991 grown in comparison with Grimm. During the winter of 1903–4 (Table VIII), Minnesota No. 2, original Turkestan S. P. I. No. 991, lost 94.7 per cent; Minnesota No. 11, Turkestan, grown at Brookings, S. Dak., from S. P. I. No. 991, lost 84.8 per cent; Minnesota Nos. 13–15, Grimm, average of 3 pure strains, lost 15.6 per cent.

Minnesota No. 11 was produced in 1900 or 1901 at Brookings from the parent stock that later produced South Dakota No. 164 (Minnesota Nos. 96–98 given below). No. 164 was itself grown at Highmore, S. Dak., in 1906 from Brookings seed.

During the severe test of the winter of 1905–6 (Table XI), Minnesota No. 1*a*, Turkestan, grown in 1904 on the station farm from S. P. I. No. 991 seeded in 1899, lost 100 per cent; Minnesota No. 2*a*, Turkestan, grown on the station farm from S. P. I. No. 991 sent to Minnesota in 1900, lost 100 per cent; Grimm, average of 4 impure strains, lost 81.8 per cent.

By an impure strain is meant one which has been grown alongside of nonhardy strains in experiments, thus giving opportunity for deterioration through cross fertilization. A pure strain is one which has not been thus exposed.

After the winter of 1906–7 (Table XIV) opportunity again offered for comparing two different progenies of S. P. I. No. 991 with Grimm:

Minnesota No. 1*b*, Turkestan, produced on station farm from S. P. I. 991, lost 58 per cent; Minnesota No. 2*b*, Turkestan, produced on station farm from S. P. I. 991, lost 42.9 per cent; Grimm, average of 4 impure strains, lost 18.5 per cent.

After two seed generations in Minnesota the Turkestan strain appears to show definite acclimatizational effects.

In 1907 Grimm alfalfa was sown for comparison with the hardy strains developed by Professor Wheeler at Brookings and Highmore, from Turkestan S. P. I. No. 991. (Table XIX.) The winter of 1908–9 gave the following results:

Minnesota No. 80 (South Dakota 240), grown at Highmore, seven years after first planting, from S. P. I. 991, lost 3.2 per cent; Minnesota Nos. 96–98 (South Dakota 164), alive in the spring of 1908, 518 were living in the spring of 1909, while 361 plants of ordinary alfalfa were reduced to 30 during the same period.

The winter of 1908–9 was practically normal as to temperature. The number of days with minima below zero was 22, the lowest minimum −26° F. The following tabulation is given to show the most salient features as to temperature, for use in connection with Tables XIX and XXI:

TABLE XX.—*Temperatures at Minneapolis, Minn., November, 1908, to March, 1909.*

Period.	Mean.	Mean of the minima.	Lowest temperature.	Days with minima below 0° F.
	° F.	*° F.*	*° F.*	*Number.*
November, 1908	36.2	28.4	5	0
December, 1908	21.0	13.0	− 8	4
January, 1909	14.5	6.5	−26	12
February, 1909	18.0	10.1	−15	6
March, 1909	29.2	22.9	2	0
For the 5 months	23.8	16.18	−26	22
For December, January, and February	17.8	9.86	−26	22

Experiments begun in the spring of 1908.—In the spring of 1908 nearly 5,000 hills of Grimm alfalfa, including 4 different numbers and 122 plants of No. 16*c*, were set out. The endurance that they showed during the winter of 1908–9 (temperatures in Table XX) is shown in Table XXI.

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grown at Highmore in 1906 from seed produced at Brookings from same stock as Minnesota No. 11 (above), lost 5.6 per cent; Grimm, 6 impure and 1 pure strain, on an average lost 4.7 per cent.

South Dakota 240 (Minnesota No. 80), acclimatized Turkestan, was grown from seed originally imported from Tashkend, Turkestan, by Prof. N. E. Hansen in 1898 under S. P. I. No. 991. It was grown at Highmore from 1899 until 1906, when the seed used in the above experiment was harvested.

South Dakota 164 (Minnesota Nos. 96–98), acclimatized Turkestan, is supposed to be from seed of the same importation as No. 240 but grown at Brookings from 1898 to 1904. Brookings seed was taken to Highmore and grown there from 1905 to 1906, when the seed used in the above experiment was produced.

Results similar to the above were obtained in the Dickinson, N. Dak., experiments briefly described later: S. P. I. No. 991, part of original importation, lost 91 per cent; P. L. H. No. 3252 (South Dakota 240), produced in 1904 after five years of unconscious selection at Highmore, from S. P. I. 991, lost 9 per cent; S. P. I. No. 21938 and P. L. H. No. 3235, Grimm, produced in Minnesota and North Dakota, respectively, lost 4.9 per cent.

Table XXI.—*Winterkilling of alfalfas in experiments begun in 1908 at St. Anthony Park, Minn.*

Minnesota No.	Source of seed.	Hills planted in spring of 1908.	Number of plants alive in—		Percentage of winter loss.
			Fall of 1908.	Spring of 1909.	
4*d*	Grimm seed from 1905 planting (Table XI, No. 4*b*)	281	279	263	5.7
13*d*	Grimm seed from 1905 planting (Table XI, No. 13*a*)	2,930	2,768	2,729	1.4
14*d*	Grimm seed from 1906 planting (Table XIV, No. 14*b*).	1,280	1,215	1,192	1.9
15*d*	Grimm seed from 1905 planting (Table XI, No. 15*a*)	219	207	207	0.0
16*c*	Original source unknown; present seed from 1905 and 1906 plantings (Table XI, No. 16*a*; and Table XIV, No. 16*b*)	122	122	121	.8

The average loss of the 4 Grimm samples was 2 per cent. The behavior of ordinary alfalfa, the average loss of which was 84.5 per cent under the same conditions, may be seen by consulting Table XIX, Nos. 76, 77, and 102. The appearance of No. 102—common alfalfa from Montana—as compared with Grimm alfalfa, is shown in Plate I, figure 2.

Conditions with respect to precipitation from April, 1908, to March, 1909, were as follows:

Table XXII.—*Precipitation at Minneapolis, Minn., April, 1908, to March, 1909.*

Period.	Precipitation.	
	Form.	Inches.
April to August, 1908	Rain	20.95
September to November, 1908	...do	6.77
December, 1908, to March, 1909	...do	.29
November, 1908, to March, 1909	Snow	33.55
Total for the entire period		33.37

Autumn moisture conditions were rather less trying than the average; winter temperatures were nearly normal, and the snowfall the greatest that occurred between 1901 and 1908. The Grimm, as in each other experiment discussed, showed itself to be inferior to none in hardiness.

By way of summarizing the results of the Minnesota experiments, it may be said that they proved without doubt the great hardiness of Grimm alfalfa. They also leave no doubt as to the nonadaptability to Minnesota conditions of all of the strains of common alfalfa that have been tried. They indicate very strongly the great importance of so locating seed plats of Grimm and other hardy strains that contamination by crossing with less hardy strains can not take place. In connection with the studies of temperature and precipitation these experiments point out some of the climatological factors of importance that control the cold resistance of alfalfa. In combination with low temperatures, snow covering, autumn moisture, and alternate thawing and freezing appeared to be the chief factors that determine the amount of winterkilling in alfalfa.

EXPERIMENTS AT FARGO, N. DAK.

The North Dakota Agricultural Experiment Station began experiments in 1902, under the direction of Prof. J. H. Shepperd, with Grimm alfalfa seed furnished by the Minnesota experiment station. The following summary of facts is gleaned from the published station reports (North Dakota Bulletins Nos. 65 and 76):

> Seed of a strain of alfalfa, named Grimm by the Minnesota experiment station, was seeded upon a plat of land last spring. The growth of the plants came on more quickly and they seemed somewhat more sturdy than those from the Turkestan seed.
>
> *Report for 1903.*—The results of the alfalfa yields for 1903 were accidentally lost, but the following statement taken from the annual report upon the field trial work that year indicates that the yield of hay was probably a little over 2 tons per acre. "The Grimm strain of alfalfa, which was sown in 1902 upon ground adjoining the Turkestan trial, has proved more thrifty and vigorous than the Turkestan strain. The Grimm alfalfa filled its seed pods with plump, ripe seeds somewhat better than the Turkestan variety, while the plants descended from Utah seed yielded an abundance of shriveled and emaciated seed which had little growing strength."
>
> *Results in 1904.*—The Grimm alfalfa plat showed a thick, strong stand in 1904, although it did not grow as high as the Turkestan variety. On June 21, the date of cutting the first crop for hay, it measured 24 inches high. The yield of hay from the first cutting was 3,720 pounds per acre. The second growth was left to ripen and was cut for seed with a binder about 10 days after it had been killed by frost. This second growth did not mature sufficiently, and the trial indicates that the first crop would have made a better yield of seed than was secured from the second growth. The yield of seed from this second growth was only 50 pounds per acre, about half of which is too immature to grow.
>
> In 1906 the Grimm alfalfa was left for seed. The stand was nearly perfect. An exceptionally heavy growth was produced, giving a yield estimated at nearly 3 tons per acre.
>
> A small plat of Grimm alfalfa growing upon an adjoining piece of land was used to propagate seed so regularly that hay yields could not be taken each season, but field observations, together with the comparison made in the season of 1904, leave no doubt that the yields of hay had they been harvested would have been greater upon the Grimm than they were upon the Turkestan plat. These plats have not winterkilled, but standing water has killed out patches of the plants.
>
> It is essential that alfalfa land be drained so as to be free from standing water, even for short periods, for such covering in the spring season seems fatal to the crop.

It will be seen from these statements that Grimm alfalfa has proved one of the most satisfactory that the North Dakota station has tested. Both Professor Shepperd and Asst. Prof. O. O. Churchill have stated in correspondence and conversation that Grimm alfalfa has proved entirely satisfactory for their section.

Seed produced on the Fargo plats in the season of 1904 was used in experiments at Dickinson, N. Dak., to be discussed later, begun in the springs of 1905, 1906, and 1908. Temperatures ranging very close to −40° F. were endured in the interim between the spring of 1902, when the seeding took place, and the fall of 1904, when the seed was harvested. Autumn moisture conditions were such that selection toward resistance in this respect also took place.

A sample of alfalfa seed purchased under the name of Grimm alfalfa was sown in test plats during the summer of 1909. After the physiologically mild winter of 1909–10, the great majority of the plants in one of the tests had been killed. In 1910 statistical studies of diversity in flower color on this sample showed a variegation of only 4.7 per cent, while the average for two strains positively known to be Grimm was 44.4 per cent. The high percentage of winterkilling and the comparative absence of variegation leave no doubt that in this case the sample was not Grimm alfalfa and that the grower who produced the seed was in error in pronouncing it Grimm and in selling it as such. Cases of this kind should serve as a warning to both buyer and seller of Grimm seed. This alfalfa is so distinct that the sale of seed that is not true to name, whether intentional or unintentional, will soon be detected.

EXPERIMENTS AT TAPPEN, N. DAK.

In the spring of 1905 the writer began an experiment to test the hardiness of 16 strains of alfalfa 6 miles south of Tappen, N. Dak. The work has been carried on in cooperation with Mr. W. H. Niles, who is, so far as we know, the largest alfalfa grower in North Dakota, having considerably over a hundred acres on his ranch, which he cut three times during the season of 1909. In this experiment, which was seeded in May, 1905, the 16 strains were sown on half-acre plats. The following table shows the estimated percentage of stand in September, 1909, at the close of the fifth season:

TABLE XXIII.—*Number, source, and estimated percentage of stand, September, 1909, on alfalfa plats near Tappen, N. Dak.*

Plat No.	S. P. I. No.	Source of seed.	Percentage of stand.
1	12816	Chinook, Mont.	90
2	12747	Billings, Mont.	90
3	12820	Clearwater, Nebr.	85
4	12671	Lawrence, Kans.	85
5	12398	Fort Collins, Colo.	60
6	12409	Spanish Fork, Utah (dry land)	30
7	12784	Emery, Utah (irrigated)	10
8	12801	Texas (Panhandle)	5
9	12702	Sherman, Tex.	5
10	12748	Hesse, Germany (Eifeler lucern)	5
11	12695	Poitou, France	5
12	11275	Europe, commercial seed	5
13	12991	Minnesota (Grimm)	90
14	13291	Fayetteville, N. Y.	30
15	13857	Simbirsk, Russia	60
16	13858	Kharkof, Russia	60

Temperatures lower than −30° F. occur practically every winter at Tappen. Nevertheless it will be noted that in the present experiments northern and southern Montana alfalfa have given as satisfactory results as Grimm. The same may be said of commercial Turkestan alfalfa, which Mr. Niles grows rather extensively. The explanation of this fact may be found in the nature of the soil, in soil-moisture conditions, and in a lack of autumn rainfall. The soil of the experimental field is an open sandy loam. The water table reaches to within 8 or 10 feet of the surface, so that the plats are not wholly dependent on rainfall for their moisture. The autumns are practically always dry, and the open nature of the soil readily takes care of any slight excess that can not be removed through the transpiration of the plants.

Many of the strains included in this experiment were duplicated in the experiments at Dickinson, N. Dak., and there is a general agreement in behavior as to cold resistance at the two places. The behavior of the Utah, Texas, and foreign strains shows how utterly unadapted these are for cultivation in cold climates.

The behavior of the Eifeler lucern from Germany is of special interest, as this sample came from the Grand Duchy of Hesse, in Germany, which is near the Grand Duchy of Baden, whence Grimm brought his original seed. The Eifeler lucern is practically identical in its botanical characteristics with Grimm alfalfa. Its physiological behavior, as may be seen from the endurance test at Tappen, is altogether different. The commercial European seed, No. 11275, also has the same botanical characteristics as Grimm alfalfa and Eifeler lucern, including greater diversity both in variegation of flower color and habit of growth than our ordinary Utah and Montana kinds. The German strain and also the commercial plat had only about 5 per cent of a stand remaining. All of these plats were cut for seed in August, 1909. The best, including the Grimm and Montana strains, yielded about 2½ bushels per acre; the Utah irrigated strain, with 10 per cent of a stand, yielded only about 10 pounds of seed; the plats with less than 10 per cent of a stand were not thrashed. The work at Tappen indicates that in the drier portions of North Dakota farmers who desire to grow alfalfa, and who can not obtain Grimm seed, should use either Montana or Nebraska strains.

It must be borne in mind that the peculiar sources of moisture supply at Tappen preclude a wide application of the results of this experiment. An experiment similar to this was begun at Minot, N. Dak., at the same time, but on account of the shortage of Grimm seed this strain was not included in the test. Minot is farther north and, on the whole, has colder winters. In spite of the fact that in order to thicken up the stand all the plants were permitted to go to seed in the summer of 1907, the seed being harrowed in, none of the plats have a stand remaining that would warrant continuing them.

EXPERIMENTS AT DICKINSON, N. DAK.[a]

Perhaps the most comprehensive and careful comparison of Grimm alfalfa with other kinds has been made at the Dickinson branch of the North Dakota experiment station. The first plat was sown in 1905, and part of it still remains. In 1906 duplicate plats were seeded in comparison with 21 other kinds. In the spring of 1908 five strains of Grimm having different histories were sown in various experiments. Each strain gave a good account of itself, especially in the hill and drill-row experiments, which furnish the severest possible test of hardiness under the conditions present. In this experiment 68 strains obtained from the most important alfalfa-growing regions of the world were given identical treatment under conditions of great uniformity.

The winter of 1908–9 was normal as a whole, with a mean temperature of 13.8° F. During January there was one period of two weeks when the highest minimum recorded was −3° F. and the lowest −31° F. During ten days of this time the maximum rose above zero only once. The preceding autumn had been moist and the snowfall was below normal.

Grouped in accordance with their immediate geographical origin the average losses in the various strains were as shown in Table XXIV. As Grimm alfalfa originally came from Europe, the average losses of 14 strains, the sources of which were known with reasonable definiteness, out of the 15 European strains are of special interest, and these are given more in detail in the table.

TABLE XXIV.—*Winterkilling of 68 strains of alfalfa in experiments at Dickinson, N. Dak., winter of 1908–9.*

Summarized record of all strains.			Separate record of 14 out of 15 European strains.		
Number of strains tested.	Source of seed.	Percentage of winter loss.	Number of strains tested.	Source of seed.	Percentage of winter loss.
4	Arabia	100	2	Russia	84
5	South America	100	5	Germany	83
3	Africa	93	5	France	90
15	Europe	87	1	Italy	99
26	North America	70	1	Spain	100
15	Asia	65			

Three of the strains attributed to Germany and 2 of the French samples were the so-called sand lucern, some lots of which have been found to be very similar botanically to Grimm. The average loss of these 5 strains was 79 per cent, the range being from 63 to 90 per cent.

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[a] Only a bare summary of the Dickinson experiments is presented here, as they have been reported upon in detail elsewhere. See Bulletin 185, Bureau of Plant Industry.

In the experiment as a whole 12 of the 68 strains winterkilled 100 per cent; 16 from 90 per cent to 99 per cent; 42 more than 80 per cent; 58 over 50 per cent; and only 10 less than 50 per cent. Of the 10 strains which lost less than half, 6 winterkilled more than 33⅓ per cent, leaving only 4 of the 68 strains that lost less than one-third. Of the 3 kinds that lost less than 10 per cent, 2 were Grimms. Their average loss was under 5 per cent, while the average for the whole experiment was 78 per cent.

EXPERIMENTS AT HIGHMORE, S. DAK.

The South Dakota Agricultural Experiment Station began to experiment with Grimm alfalfa in 1902, but the seed used came from a commercial source and appears not to have been true to name. At any rate, in careful experiments in hills at the Minnesota experiment station in which true Grimm was compared with this so-called Grimm the following differences in winterkilling were apparent:

TABLE XXV.—*Winterkilling of alfalfas in experiments at Highmore, S. Dak.*

Variety.	Number of plants alive in the—		Percentage of winter loss.
	Fall.	Spring.	
True Grimm	217	194	11
So-called Grimm	174	25	86

In 1905 true Grimm seed was obtained and planted. According to Prof. W. A. Wheeler [a] this strain did not, during the winter of 1905–6, lose a single plant either in selection rows or plats under varying conditions at Highmore and Brookings. Wheeler's observations, as given in the bulletin referred to are as follows:

> *No. 162.*—The seed of this number is, according to records, from the same original source as No. 67, the so-called Grimm alfalfa referred to above, but in all tests made during the last two years the results obtained from these two numbers are at variance. No. 162 is very much hardier than No. 67; in fact it seems to be perfectly hardy, as not a plant was known to winterkill in 1905–6, either in selection rows or in plats under varying conditions at Brookings or Highmore. The selection-row test for hardiness is the most severe test that can be given, as the plants, when grown in these rows, have 3 feet of bare ground on each side of them. In quality of forage and in the vigor of growth in early spring, this number is second to none listed here. In seed production it is one of the best but has not been compared a sufficient length of time with No. 167 to determine which produces the greater amount and better quality of seed.

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[a] Wheeler, W. A., and Balz, S., Forage Plants at the Highmore Substation, 1906, Bulletin 101, South Dakota Agricultural Experiment Station, 1907, p. 136.

> The Grimm alfalfa, which is the original No. 162, has been grown near Excelsior, Minn., for about forty years and appears to be thoroughly acclimated to Minnesota conditions as far as forage value is concerned. In Minnesota, however, it fails, under ordinary conditions, to produce seed readily. The Grimm alfalfa has been tested in many parts of the United States as well as Canada and has shown itself to be one of the hardiest, if not the hardiest alfalfa under trial either by the State stations or by the United States Department of Agriculture. A plat of this variety was seen by the writer at Indian Head, Saskatchewan, in the summer of 1906, which was being grown in comparison with several others. [For details of this experiment, see pp. 44–47.] It had passed through two winters without winterkilling in the least, and was making a very fine growth, while others under trial had, to a large extent, winterkilled. South Dakota No. 162, which is the Grimm acclimated to South Dakota conditions, ranks with the two or three best alfalfas for South Dakota.

Temperature and autumn moisture conditions at Highmore during the progress of Wheeler's experiments were such as to give a reliable test of hardiness, especially as the Grimm and many of the strains with which it was compared were grown in hills and nursery rows. Winters that do not register temperatures 20 or more degrees below zero are rare at this point, the lowest temperature thus far recorded being about −40° F. (−40° C.).

EXPERIMENTS AT FAYETTEVILLE, N. Y.

In the spring of 1905 an endurance test of 14 regional strains of alfalfa was seeded in cooperation with Mr. F. E. Dawley, on his farm near Fayetteville, N. Y. The series of alfalfas used in this endurance test is similar to that described above, at Tappen, N. Dak. In August, 1909, Mr. T. R. Robinson, Assistant Physiologist in the Office of Soil-Bacteriology and Water-Purification Investigations, kindly visited these plats, and in company with Mr. Dawley, made notes in regard to their present condition. Only 4 of the 14 were maintaining a good stand and on August 24 were ready for the third cutting. These, in order of their excellence, were as follows:

S. P. I. No. 12991, Grimm alfalfa from Minnesota.
S. P. I. No. 11211, Turkestan alfalfa from Samarkand.
S. P. I. No. 12409, Dry-land alfalfa from Emery, Utah.
S. P. I. No. 11275, Commercial alfalfa from Europe.

The following concerning the remaining strains is quoted from Mr. Robinson's report:

> Poiton, France, 12695, and Italian 12696 may be classed as entire failures; in fact they had been partially plowed up. Colorado 12398, Utah irrigated 12785, and Texas Panhandle 12801 are only fair. Sherman (Tex.) 12702 was poor. Chinook (Mont.) 12747, Nebraska 12820, and Kansas 12671 are dying out in spots, leaving some bunches still growing well, but not a good stand.

In 1906 and 1907 the hay product of these plats was weighed. In 1906 three crops were cut; in 1907, on account of drought, only two. In both years Grimm alfalfa outyielded all other kinds; in two or three cases only slightly, in others giving more than twice the yield. For instance, comparing Grimm with the Turkestan strain (No. 11211), which Mr. Robinson found was maintaining almost as good a stand, Grimm yielded in 1906 a total crop of 7,450 pounds as against 3,340 for the Turkestan. In 1907 Grimm yielded in two cuttings 5,440 pounds as compared with 2,300 pounds for the Turkestan. Compared with the Utah nonirrigated seed No. 12409 (which in the autumn of 1909 was still one of the four best plats), Grimm in 1906 yielded 5,440 pounds; Utah, 4,820. Compared with Italian No. 12696 (which has a very similar varigation in flower color), Grimm in 1906 yielded 7,450 pounds as against 3,990 for the Italian; in 1907 the yields were 5,440 pounds for Grimm and 2,810 pounds for the Italian. These figures indicate that the Grimm can be depended upon not only on account of its superior hardiness, but also because of its hay-yielding capacity.[a]

TABLE XXVI.—*Monthly minimum temperatures, total snowfall, and rainfall during preceding autumns at Fayetteville, N. Y., 1905–1909.*

Season.	Monthly minimum temperatures.				Precipitation.	
	December.	January.	February.	March.	Snow.	Rain during preceding autumn.
	°F.	*°F.*	*°F.*	*°F.*	*Inches.*	*Inches.*
Winter of 1905–6	−2	−20	−22	−4	45	7.95
Winter of 1906–7	−13	−20	−13	−4	37	10.67
Winter of 1907–8	0	−12	−20	8	52	10.10
Winter of 1908–9	4	−13	−8	10	67	4.14

While the winter temperatures at Fayetteville are moderately low, the snowfall is so heavy that their injurious effects are considerably reduced. On the other hand, excessive autumn moisture, which leaves the soil in a saturated condition, constitutes an unfavorable factor which tends to equalize the severity of conditions in this area, as compared with the cold portions of the Great Plains, where very low temperatures, preceded by rather dry autumns, are the rule.

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[a] It should be stated that while Turkestan alfalfa frequently shows a satisfactory degree of hardiness it does not, as a rule, make the growth nor give the yield of either hay or seed that Grimm does. This has been pointed out as regards hay production in Professor Shepperd's experiments at Fargo and was again evident in the present experiment at Fayetteville. It seems likely that this is due to the fact that the Turkestan strains are accustomed to much higher summer temperatures than prevail in our northern country. Wheeler's experiments in South Dakota tend to indicate that as acclimatization progresses these faults in the Turkestan become less and less apparent in successive seed generations. In the case of both the Tappen and Fayetteville experiments it was the intention to subject the varieties to such conditions as they would be called upon to endure in actual farming practice.

EXPERIMENTS AT BOZEMAN, MONT.

The Montana Agricultural Experiment Station at Bozeman has also tested Grimm alfalfa in comparison with a number of other kinds, including seed from various parts of Montana, and also a collection of about 10 strains from various parts of Turkestan.[a] The results of these experiments have not yet been published. In a letter under date of October 8, 1909, Prof. Alfred Atkinson, agronomist of the Montana station, makes the following statement:

> Our experiments with Grimm alfalfa indicated that it is decidedly the best for many sections of the State. Two years ago a large percentage of the plants in the different variety plats were winterkilled, but the Grimm alfalfa showed no injury. * * * I certainly consider it a plant worth putting forward, and hope to be able to get it out to Montana farmers in two or three years. * * * I may say that the seed produced in northern Montana is said to be very superior. In our tests at Bozeman this did not show up quite so well as the Grimm alfalfa. Montana-grown seed of the common strain, however, shows itself to be much hardier than any of the strains of Turkestan which we included in the tests.

Although the data upon which Professor Atkinson bases his conclusions have not yet been published, it is evident from this summary that they coincide with the results at St. Anthony Park, Minn., Dickinson, N. Dak., and other places where Grimm alfalfa has been tested in comparison with other kinds.

EXPERIMENTS AT INDIAN HEAD, SASKATCHEWAN, CANADA.

During the winter of 1904–5 arrangements were made with Dr. William Saunders, director of experiment stations for the Dominion of Canada, for a cooperative experiment with a number of varieties of alfalfa on the experimental farm for Saskatchewan at Indian Head. This work has been carried out under the immediate supervision of Mr. Angus Mackay, superintendent, and the data given below are based upon the reports which Mr. Mackay has furnished from year to year. The alfalfas in the series shown in Table XXVII were sown in May, 1905:

TABLE XXVII.—*Condition of alfalfas in the spring of 1906 in experiments begun in 1905 at Indian Head, Saskatchewan, Canada.*

S. P. I. No.	Source of seed.	Condition in the spring of 1906.
12747	Billings, Mont. (irrigated)	Almost all killed; plat plowed up.
12409	Diamond Fork, Utah (nonirrigated)	Do.
9303	Peru, South America (irrigated)	All dead; plat plowed up.
11211	Samarkand, Turkestan	About 60 per cent of the stand remaining.
11275	First quality commercial (variegated alfalfa from Europe).	Almost all killed; plat plowed up.
12991	Carver County, Minn. (Grimm)	About 95 per cent of the stand remaining.
13237	Chinook, Mont. (irrigated)	About 20 per cent of the stand remaining; plat plowed up.
13291	Fayetteville, N. Y	About 50 per cent of the stand remaining.
13259	Milburn, Nebr	Do.

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[a] Among the strains tested were S. P. I. Nos. 9359, 9450, 9451, 9452, 9453, 9454, 9455, 9816, and 11211.

All of these plats went into the winter of 1905–6 with a fairly good stand, as the summer of 1905 had been an exceedingly favorable one for alfalfa. Nineteen inches of rain fell during the growing season. It seems likely that when winter arrived a saturation of the soil existed that was decidedly injurious to all strains, except the Grimm, which is thoroughly acclimatized to a moist condition of the soil, accompanied by exceedingly low temperatures.

The Grimm and Samarkand strains made the quickest recovery after cutting in 1905, and the Grimm was the earliest to begin growth in the spring of 1906. Only 4 of the 9 kinds named above kept a sufficient stand to warrant continuing the plats after 1906. The hay yields for these three years are shown in Table XXVIII:

TABLE XXVIII.—*Calculated yield in pounds per acre of alfalfa varieties at Indian Head, Saskatchewan, Canada, 1904–1909.*

Cutting.	Common.	Turkestan.	Minnesota (Grimm, S. P. I. No. 12991).	New York (S. P. I. No. 13291).	Turkestan (S. P. I. No. 11211).	Nebraska (S. P. I. No. 13259).
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1904	(a)	(a)	....	....	....	....
1905 First cutting	4,422	5,480	....	....	....	....
1905 Second cutting	2,900	3,360	(a)	(a)	(a)	(a)
Total	7,322	8,840	....	....	....	....
1906 First cutting	960	1,800	4,181	(b)	(b)	(b)
1906 Second cutting	1,020	1,940	2,931	2,500	2,560	2,450
Total	1,980	3,740	7,112	....	....	....
1907 First cutting	....	....	(c)	(d)	(d)	(d)
1907 Second cutting	....	....	....	3,818	3,909	3,038
1908 First cutting	....	....	6,136	6,704	5,636	4,367
1908 Second cutting	....	....	2,955	3,227	3,026	2,358
Total	....	....	9.091	9,931	8,662	6,725
1909 First cutting	....	....	5,318	4,000	3,910	3,090
1909 Second cutting	....	....	(e)	(e)	(e)	(e)
Grand total	9,302	12,580	21,521	20,249	19,041	15,303

[a] Clipped but not weighed first year.
[b] Cut for weeds.
[c] Left for seed.
[d] Cut only once.
[e] Put in silo; not weighed.

It will be noted from the table that in 1906 the Grimm yielded two good cuttings, while the other less hardy strains from New York, Turkestan, and Nebraska were cut for hay but once. Common alfalfa, which had yielded 7,322 pounds in 1905, and Turkestan alfalfa, which had yielded 8,840 pounds in the same year, were so seriously injured by the winter of 1905–6 that their yields were cut down to 1,980 and 3,740 pounds, respectively. This is the same winter that injured so badly the alfalfa in the experiments at St. Anthony Park, Minn., discussed above. It also proved very injurious to Wheeler's experiments at Highmore and Brookings,

S. Dak., and is the only winter of recent years that has seriously injured stands of Grimm alfalfa in Carver County, Minn. In another publication[a] the injurious effects of this winter have been attributed to an excess of moisture in the soil due to heavy autumn precipitation in 1905.

In 1907 the Grimm alfalfa plat was left to go to seed and was not cut until September 23. The New York, Turkestan, and Nebraska strains were cut but once, on July 22, the subsequent growth being left for winter protection. By 1908 the thinned-out stand on the three last-named plats had considerably improved through the greater development of the plants due to the added space available for each individual. In this year two cuttings were made. In 1909 two cuttings were made, but only the first was weighed, the second being put in the silo without weighing.

In the five years for which data as to yields are available the grand total yield of the Grimm for three years, 21,521 pounds, exceeds that of the next best plat, that from New York, which yielded 20,249 pounds in four years.

In his letter transmitting report for 1906 Mr. Mackay made the following statement:

> When I reported to you in April last spring most of the plats had just started, but by May 15 all were dead excepting those mentioned [Table XXVII] as giving some returns. One variety only—Minnesota Grimm—was not injured by the frosts and gave two cuttings.

Again, in sending in his report for 1908, special comment is made on the Grimm:

> From the first the Grimm alfalfa has never been winter or spring killed in the least, and on this account I consider it the most valuable strain for this country. Last year the New York, Samarkand, and Nebraska gave good returns, but in the previous year all were more or less injured by spring frosts and thaws.
>
> I may say that the spring of 1908 was an exceptionally good one for clovers, * * * and all strains whether of alfalfa or of red clover stood perfectly; the season being favorable in regard to moisture and heat, good yields were the result in all cases.

Again, in transmitting his report for 1909, Mr. Mackay made the following statement:

> I am very glad to report favorably on the Grimm alfalfa obtained from your department in 1905; in no year has it been injured or killed by spring frosts, and I have great hopes that in the future it will not fail in this respect.
>
> Next spring it is the intention to sow 25 to 30 acres with alfalfa and if the seed can be obtained the Grimm will be used.

The results at Indian Head add confirmation to those already reported on in experiments at other places. There seems no room for reasonable doubt as to the great hardiness of the Grimm alfalfa for our northern country and Canada and its great consequent potential value.

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[a] Bulletin 185, Bureau of Plant Industry, p. 62.

EXPERIENCES OF FARMERS.

The results obtained by investigators, as detailed above, have been borne out by experiences of many practical farmers, especially in the Northwest, but also in other parts of the North.

In the spring of 1901 Mr. Clarence Wedge, of Albert Lea, Minn., seeded both Grimm and Turkestan alfalfas. The Grimm was sown on poorly prepared soil which had been spring plowed. The Turkestan seed fared better; it was sown on fall-plowed land that had been in corn and was thoroughly prepared. Despite this advantage the Turkestan field lasted only about two years, while the Grimm lasted six years. It still had a good stand in the autumn of 1905, but by the spring of 1907 was so badly injured that it had to be plowed up. The disastrous effects to alfalfa in Minnesota of the fall and winter of 1905–6 have already been discussed in connection with the work at St. Anthony Park (pp. 27-29).

Mr. A. B. Lyman's experiences with commercial alfalfa seed, about 1891 to 1892, have already been touched upon. In 1894 he began growing Grimm alfalfa and since that time Grimm alfalfa has been grown continuously on his farm; once as many as 100 of his 250 acres were devoted to it.

A number of Mr. Lyman's neighbors have tested commercial lots of seed, both of domestic and foreign origin. He has had uniform success; they, uniform failure. In the spring of 1906 Mr. Matt Bongard, a near neighbor, seeded a field with a grass mixture, one-third of which was first-quality commercial alfalfa seed that came from Europe. According to the best information obtainable an excellent stand of plants resulted, in which the alfalfa largely preponderated, though considerably less than the customary amount of seed was applied. In September, 1909, after three winters, less than 3 per cent of a stand remained on this field. Such experience is not unusual, as even more extreme cases have come under the writer's observation when Minnesota farmers have attempted to grow nonhardy strains of alfalfa.

Not more than 1,000 feet away from Mr. Bongard's field Mr. August Kelm has a field of Grimm alfalfa shown in Plate II, figure 1. This field is 11 or 12 years old, and retains about 80 per cent of the stand, though the original seeding in this case also is said to have been thin. Even the 25-year-old field of Grimm shown in Plate I, figure 1, has four or five times as many plants remaining per unit of area as the 3-year-old field of newly imported alfalfa on the Bongard farm.

Mr. Alfred Maxwell, of Excelsior, Minn., has a small field of Grimm alfalfa that is over 20 years old, and still has a good stand. On another part of his farm he has a field about 7 years old sown with commercial seed. Its stand is so thin that it should be plowed up. Near the field of commercial alfalfa Mr. Maxwell has a hog pasture that was seeded to Grimm about the same time the commercial lot was sown. Despite the harsh treatment due to pasturing this Grimm field retains fully 60 to 70 per cent of the stand.

Mr. George Schoolmeester, another Carver County farmer, used some commercial seed about six years ago to finish sowing one of his Grimm fields. In two years the commercial strain had almost totally killed out. The Grimm still retains a full stand, although it was seeded very thinly.

Mr. Isaac Lincoln, of Brown County, S. Dak., has 7 acres of Grimm alfalfa that kept a perfect stand after the winter of 1908–9, when other strains winterkilled extensively in his section. In the spring of 1909 he made a new seeding of Grimm of equal area.

In the spring of 1904 Endsley Bros., of Milford, Ill., seeded 100 pounds of Grimm alfalfa. At the same time a near neighbor seeded ordinary Kansas alfalfa on the same type of land. In three years the ordinary alfalfa had all killed out, while the Grimm, according to statement of Mr. P. M. Endsley of Excelsior, Minn., still retained a perfect stand in the fall of 1909. In the spring of 1908 another seeding of 220 pounds of Grimm alfalfa was made, and although that season was very unfavorable, the result was a good stand that successfully endured the winter of 1908–9.

Scores of other cases could be cited in which Grimm alfalfa has made good in the experience of practical farmers. The writer has the names and addresses of fully 500 farmers who are now growing or have grown this variety; some of them on small plats only, others on a field scale.

OTHER CHARACTERISTICS OF GRIMM ALFALFA.

The behavior of Grimm alfalfa in respect to other characters than hardiness remains to be discussed.

FORAGE-PRODUCING CAPACITY.

In the area for which it is recommended, other things being equal, Grimm gives more and fuller crops, and hence larger yields than any other kind. This no doubt is largely due to its hardiness, by virtue of which it maintains more perfect stands over a longer period of time than other sorts.

In Carver County three good crops of hay are generally harvested. The dates of cutting vary greatly with different seasons. The earliest date for harvesting the first crop of which the writer knows is May 28; the latest date, June 15. The second crop is usually cut between July 10 and 20; the third between August 25 and September 10.

There is usually a generous aftermath in the way of a fourth growth. The German farmers generally pasture this with cattle or horses, rarely with sheep. The ability of the Grimm to endure autumn pasturing is of great advantage to the farmer and adds much to the money value of the variety. Unacclimatized strains can not bear this hard usage.

The writer is familiar with a field of Grimm now 9 or 10 years old which soon after being seeded was used as pasture for a large number of horses from early autumn until late spring. The ground in spring appeared to be bare. Nevertheless, a profitable stand remains to this day on this field, which has been repeatedly pastured in autumn.

Mr. Lyman finds hog raising very profitable in connection with alfalfa growing, and frequently cuts his fourth growth for feeding hogs. No observable injury to his stands has resulted from this practice. In the Northwest, when commercial strains of alfalfa are pastured or given late cuttings they rarely last as long as three years.

GENERAL BEHAVIOR AND TEMPERATURE RELATIONS.

As a general thing nonhardy strains of alfalfa pass through their first winter without great loss. This is especially true when seeded with grain. The explanation is not difficult to find. The grain stubble serves to hold the snow, thus furnishing protection to the alfalfa. If seeded without a nurse crop and cut late, these strains frequently kill out so badly during their first winter as to necessitate immediate plowing up.

Grimm alfalfa has great germinative energy and makes satisfactory stands with very thin seeding. It may be sown either with or without a nurse crop; but preferably without, using not more than 15 pounds of seed per acre.

In the North and Northwest, Grimm begins effective growth earlier in spring and continues later into the autumn than any of the numerous kinds with which it has been compared, but South Dakota No. 167, the so-called Baltic alfalfa, resembles it closely in this respect. Often it is ready to be cut when other kinds are yet only half grown. This ability to utilize to the full the rather short growing season of our northern country, combined with unusual hardiness, is of great value.

The physiological factors involved in the early and late growth of Grimm alfalfa have not yet been studied. It no doubt has most intimate relation to the faculty of prompt response in spring to growth-producing stimuli. Similarly, prompt reaction to conditions tending to produce dormancy in autumn is believed to have much to do with the winter hardiness of the variety. The adjustment of Grimm alfalfa to the climatic conditions that prevail in the Northwest is such that it utilizes available growing temperatures to the full limit. On the other hand, when cold weather really sets in, the variety passes quickly from active growth into its resting state. This physiological adaptation of quick response at the right time may readily be the effect of natural selection in a climate which has very marked seasons and where the transition from one season to another is a quick one. The preliminary observations that have been made indicate that the temperature relations of our important crop plants offer an attractive and fruitful field for investigation.

The hardy Grimm alfalfa and the tender Peruvian variety[a] stand in peculiar contrast in their relative behavior in the Northwest and Southwest. In Arizona, during winter, while the Grimm makes practically no growth, the Peruvian may grow all winter and be ready for first cutting before the end of February, just when the Grimm begins to grow again. On the other hand, the northwestern winter usually kills the Peruvian out completely the first winter after seeding, while the Grimm, when broadcasted or drilled in the ordinary way, rarely suffers to an observable degree. During the intense heat of summer in the Southwest growth is almost wholly arrested in the Grimm, but continues without interruption in the Peruvian. These differences have been explained[b] as due to differences in the location of the zero point of growth of the two varieties. Peruvian has a low zero point and fails to become dormant as the weather grows cold. Grimm has a higher minimum and becomes dormant promptly in autumn, thus escaping injury when really cold weather arrives.

These points illustrate in a measure how complex the temperature relations of alfalfa are, and also the great acclimatizational possibilities of the crop when grown for a long time under different sets of climatic conditions.

Ability to begin growth promptly in spring is of especial importance to alfalfa growing in the North. This was pointedly shown in the experiments at Indian Head, Saskatchewan. During the winter of 1905–6 (Table XXVII) 5 kinds killed out so badly that they had to be plowed up. Of the 4 kinds that were left only the Grimm made a first crop that was worth cutting. It yielded over 3½ tons of hay per acre during the season of 1906, while the best of the other strains produced only a little over 1¼ tons.

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[a] Brand, C. J. Peruvian Alfalfa: A New Long-Season Variety for the Southwest. Bulletin 118, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1907.

[b] Brand, C. J., op. cit., pp. 8–14.

The same conditions were in evidence in Fayetteville, N. Y., where Turkestan No. 11211 maintained almost as good a stand as Grimm. But in 1906, while the former produced only 3,340 pounds of hay per acre, the latter yielded 7,450 pounds.

SEED-PRODUCING CAPACITY.

Ability to set seed freely is of the greatest importance in bringing about the extension of a valuable variety of alfalfa. The statement has frequently been made, without proper foundation in fact, that Grimm alfalfa is a poor seeder. If this were true, the wide use that should be made of it would be almost impossible of attainment. Fortunately, this is not the case.

Under favorable conditions Grimm alfalfa has proved to be one of the most prolific in seed production. Wheeler's results at Highmore and Mitchell, S. Dak., have been of especial interest. About 2 ounces of seed of South Dakota 162, which is the Grimm, were sown in a cold frame in the early spring of 1907. Later something over 4,000 plants of the variety were transplanted to about four-tenths of an acre of ground. In September this area yielded about 80 pounds of seed, which is at the rate of 200 pounds per acre. Wheeler's plants were set out in rows with 1½ feet between plants and 3 feet between rows. During 1909 he harvested as much as 200 pounds of seed that traces its ancestry back to an individual plant.

Similar results have been obtained by Mr. A. C. Dillman,[a] of the Office of Alkali and Drought Resistant Plant Breeding Investigations, on the experiment farm at Bellefourche, S. Dak., conducted by the Office of Western Agricultural Extension Investigations. Mr. Dillman found that Grimm alfalfa was "superior to all other stocks tested, in seed production, hardiness, and in forage type of plant." His Grimm selections gave the highest yield of seed per individual plant of any of the varieties in his work. Five hundred plants in rows with 21 inches between plants and 42 inches between rows yielded at the rate of 260 pounds per acre. Furthermore, the Grimm plants also gave the highest yield of hay per individual plant.

Another example of the vigor of Grimm alfalfa in seed production occurred in plat No. 16 (Pl. II, fig. 2), at Dickinson, N. Dak., during the past season. After passing through the winter of 1908–9, which was so destructive to ordinary alfalfas seeded under similar conditions, this plat, which contained one-tenth of an acre, yielded

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[a] See "Breeding Drought-Resistant Forage Plants for the Great Plains Area," Bulletin 196, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910, pp. 12–20.

33.6 pounds of clean seed. This is at the rate of 336 pounds or 5.6 bushels per acre.[a] This plat was sown in rows 3 feet apart.[b] In a number of other authentic cases that have come under the writer's observation, Grimm alfalfa in the North has outyielded in seed all other kinds under identical conditions.

The only basis that exists for the statement that Grimm is inferior in seed production lies in the fact that seed has been scarce, hence expensive and hard to get. This meagerness in the supply of seed depends directly on the character of the summer weather that generally prevails in Carver County. As long ago as 1867 Mr. Grimm produced 480 pounds of seed from about 3 acres. There is rarely a year when some seed is not produced, though most seasons are unfavorable for maximum crops. The second growth is generally left for seed-producing purposes and it often happens, as was the case during the summer of 1909, that the alfalfa blooms profusely, giving promise of a heavy seed crop. Then the weather changes and several rainy and cloudy days occur. The almost invariable result of wet weather is that the flowers blast and fall without forming seed.

Seed production of alfalfa is generally uncertain everywhere, but especially in humid climates. Dry and hot weather seems essential to the production of large seed crops. In Minnesota optimum conditions only come occasionally. This is one of the important reasons why Grimm alfalfa has not spread more rapidly over the North and Northwest, but it is not the only reason.

Ordinary American alfalfa was introduced into California only four years before Grimm brought his alfalfa to Minnesota. Since 1854 the former has covered probably as much as 5,000,000 acres in the western third of the United States.

Since 1858 Grimm alfalfa has covered a total of possibly 3,000 acres, confined largely to one county in the State of Minnesota. Many causes have combined to bring about this marked difference in the area occupied by these two races of alfalfa. A very important one has already been touched upon, namely, the unfavorable conditions for seed production that usually prevail in Carver County. In this connection it must be said that very often in years when the seed supply was ample the local demand was so small that in several cases rather large quantities of seed were shipped to Minneapolis and sold at the price commanded by ordinary alfalfa. It seems likely that this early lack of appreciation of the value of Grimm alfalfa was based on the fact that for many years its cultivation was precarious. A period of nearly twenty years was required to free the foundation stock from nonhardy individuals. As late as 1875 what might be termed wholesale winterkilling still took place. This process of purification, to which the writer has for several years in correspondence and conversation applied the term "selective acclimatization," is not yet complete.[a]

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[a] The seed yield of alfalfa in recognized seed-producing sections usually ranges from 3 to 5 bushels per acre.

[b] The seed used on this plat was grown in 1907 by Mr. Gustav Rasche at Westbrook, Cottonwood County, in southwestern Minnesota. This place is about 150 miles from St. Bonifacius, where Mr. Grimm made his first seeding in 1858. Mr. Rasche obtained his original seed from Mr. Henry Peterman, of Waconia, Carver County, in 1893 or 1894, so that this strain has been isolated from the rest of the stock for about fifteen years.

Mr. Peterman deserves mention as one of the farmers who early realized the value of Grimm alfalfa and who did much to promote its cultivation by saving seed and distributing it among his neighbors.

Grimm alfalfa has now become so hardy that in recent years there has been less elimination of unfit lines of descent than during the early years. Nevertheless, weeding out still takes place in winters of unusual severity in any particular respect. A case of this kind was witnessed in 1905-6, when an exceedingly moist autumn with almost 2 inches of rain and a high mean temperature for November changed suddenly to winter with a temperature of −8° F. on the last day of that month, followed by an almost snowless December.

DROUGHT RESISTANCE.

The question as to whether Grimm alfalfa is especially valuable because of drought resistance is still undecided, though it has given good results in Minnesota in very dry years. In experiments under dry-farming conditions near North Platte, Nebr., in the Panhandle of Texas, and near Nephi, Utah, it has shown no marked superiority in this respect. In 1907, at North Platte, 4 strains of ordinary American alfalfa outyielded it. These included seed from Nebraska, Kansas, Colorado, and the Panhandle of Texas. Seven other strains, including 2 Turkestan samples, Poitou alfalfa from France, Texas alfalfa from Grayson County, Utah, irrigated and nonirrigated, and Montana irrigated alfalfa, gave practically the same yield as the Grimm. The rainfall of 1907 at North Platte was 19.61 inches, about an inch above normal. In 1908, with practically 20 inches of rainfall, 6 strains gave considerably better yields than the Grimm, 6 about the same or slightly better, and 6 lower yields.

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[a] The hardiness of Grimm alfalfa has now become so well fixed that recently a belief that it was always as hardy as it is now has gained some ground. Had this been the case it seems likely that the experience with ordinary alfalfa would have repeated itself and this crop would occupy as prominent a place in the agriculture of the North and Northwest as it now does in that of the West and Southwest. Alfalfa has been grown in Minnesota twenty years longer than in Kansas. Kansas now has 1,000,000 acres in round numbers, Minnesota possibly 5,000 acres all told.

Grimm has been grown at the South Dakota substation at Highmore since 1905. The precipitation for the years 1905 to 1908, inclusive, was as follows:

TABLE XXIX.—*Precipitation at Highmore, S. Dak., 1905–1908.*

Years.	Precipitation (inches).	
	Growing season (April to August).	Annual.
1905	21.4	26.4
1906	17.5	24.9
1907	11.3	17.3
1908	16.0	22.4

The normal annual rainfall for Highmore is a little more than 17 inches, while the growing-season normal is 12.25 inches. Only the year 1907 was dry enough to give any test whatever of drought resistance. No report has been issued on the work of that year, but Grimm is said to have given fully as good results as the strains that were grown in comparison with it.

These data indicate that Grimm alfalfa offers no particular advantage with respect to drought resistance as compared with our ordinary strain, hence its use should be confined to the regions where cold resistance is of primary importance and to the northern Great Plains where the most successful alfalfa must be both cold resistant and, in a measure, drought resistant.

SUMMARY OF BEHAVIOR.

By way of summarizing the account that has been given of the behavior of Grimm alfalfa it may be said that in the North its effective growth begins earlier and continues later than that of any other strain that has been successfully cultivated in this area. In Minnesota it usually produces three good hay crops and enough additional growth for pasture or for hog feed. It has unusual vigor in seed production, and under equal conditions in the Northwest matures its seed earlier and gives higher yields than any other kind, with the possible exception of South Dakota No. 167. With reference to its drought resistance it may be said to be up to the average in this respect, though it has not proved superior in any of the writer's experiments.

THE POSSIBILITIES OF GRIMM ALFALFA.

Alfalfa is one of the greatest wealth producers among our farm crops. In a little more than fifty years its value to American agriculture has increased from nothing to about $150,000,000 per year.

After deducting the cost of labor, the depreciation in machinery, and all other expenses legitimately chargeable to cost of production, what remains of this annual value would pay more than 5 per cent on an investment of $1,500,000,000.

The average yield per acre of alfalfa for the whole United States is over 2½ tons per acre. According to the figures of the Bureau of Statistics of the Department of Agriculture this is twice as great as the average for all other kinds of hay.

At present the great benefits that come from the cultivation of alfalfa are enjoyed almost exclusively by the western and southwestern third of the United States. In an area including nearly all the farming lands north of the forty-second parallel between the Atlantic and the Rockies, in both Canada and the United States, alfalfa is an important desideratum. On this side of the Canadian line the total area concerned is fully 800,000 square miles, in which probably not more than 75,000 acres of this valuable crop are now grown.

The existence of this condition is due almost solely to lack of seed of a variety that can be depended upon to endure the trying weather of the fall, winter, and spring months.

With an area of a little over 80,000 square miles, where our so-called ordinary American alfalfa proved so readily adaptable, Kansas alone has, in round numbers, 1,000,000 acres of alfalfa. Minnesota, with a larger area than Kansas, probably has less than 5,000 acres all told. North and South Dakota, with a combined area almost twice that of Kansas, have possibly 10,000 or 15,000 acres between them.

The establishment of a successful alfalfa industry in the North and Northwest such as exists in Kansas will mean the addition of millions of dollars to the annual value of farm products of these regions. In the Northwest especially, with the passing of wheat growing, there is great need for alfalfa as a basis of beef and pork production and for dairying purposes. If Kansas, with an area of something over 80,000 square miles, produces an alfalfa crop having a farm value of about $6,000,000 annually, what may we not expect in an almost virgin area of 800,000 square miles?

CONCLUSION.

It now becomes a matter of the greatest importance to propagate a sufficient supply of seed to grow Grimm alfalfa generally in the area to which it is suited. Only by a determined effort can a successful alfalfa industry be established in the North and Northwest. Conditions with reference to seed production are decidedly unfavorable, and inability to obtain seed has been the greatest barrier in recent years to the wide utilization of Grimm alfalfa. A number of public and private agencies are at present attempting to produce supplies of seed. The most that can be hoped for from present efforts will fall far short of proving adequate to the demand.

No reliable figures whatever are available as to the acreage of Grimm alfalfa now in existence. It can, however, be safely said that it does not exceed 3,000 or 4,000 acres. While this is a comparatively small acreage, it is a great step toward the ultimate goal. In the case of no other variety of proved hardiness, equal or nearly equal to that of the Grimm, are as many as 100 acres available as a basis for an industry.

It is in a measure a public duty for growers having Grimm fields to produce as much seed as possible in order that it may be sold at a price within the reach of every northern farmer. Those who now have fields or plats of Grimm should grow seed whenever possible, even if so doing sometimes causes a loss to them as compared with the returns from hay production. Farmers who are experimenting with Grimm and who now have poor stands from one cause or another are advised when plowing up these fields or plats to transplant the crowns into rows on well-prepared ground, and to utilize these rows for seed production. The selection which such plats have undergone undoubtedly gives added value to the seed produced.

Certain precautions must, of course, be taken to insure success. Of these the following seem the most important:

(1) The use of genuine seed.
(2) Proper tillage methods.
(3) Inoculation.
(4) Isolation of seed plats from other nonhardy kinds.

Experiment stations, seedsmen, individual farmers, and seed breeders' associations, such as the Wisconsin Agricultural Experiment Association and the Minnesota Field-Crop Breeders' Association, should take up the work of producing seed at prices within the reach of every intending grower. In addition, seed growers' unions might be organized to advantage.

Farmers who desire to sow Grimm alfalfa but can not obtain seed enough for acreage plantings should purchase smaller quantities, and produce the seed they require by means of seed-increase plats, or by sowing in cultivated rows, as described in Circular 24[a] of the Bureau of Plant Industry.

In selecting a piece of ground for use in growing seed care should be taken to see that it is well drained. In most of our northern country, in order to insure desirable dryness in summer, it may be advisable to select a rather light soil. Seeding can be done with almost any of the ordinary garden drills, the rows being left far enough apart to allow cultivation with a horse cultivator. The best crop to leave for seed varies from year to year with the season. The second crop has often been used in Carver County with fair success. The principal point to bear in mind is that a period of hot, dry weather is most favorable to seed production. If in any section such periods recur with regularity during the summer, cutting or clipping should be timed accordingly.

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[a] Brand, C. J., and Westgate, J. M. Alfalfa in Cultivated Rows for Seed Production in Semiarid Regions, Circular 24, Bureau of Plant Industry. Copies of this circular can be secured without cost by application to the Secretary of Agriculture, Washington, D. C.

The potential value of Grimm alfalfa, as indicated by the experiments of the Bureau of Plant Industry, the State experiment stations, and individual farmers in the North and Northwest, is so great that no effort should be spared to bring about its general use in the area for which as indicated by experiments it is especially valuable.

SUMMARY.

The establishment of a successful alfalfa industry in the North and Northwest, such as exists in Kansas, Nebraska, and the States farther west and southwest, will mean literally the addition of millions of dollars to the annual value of the farm products of this region.

Alfalfa is one of the greatest wealth producers among the farm crops of the United States. In a little more than fifty years the value of its product has increased from nothing to about $150,000,000 per year.

At present the enormous benefits accruing from the growing of alfalfa are enjoyed almost exclusively by about one-third of the total area of the United States. North of the forty-second parallel, between the Atlantic and the Rockies in both the United States and Canada, very little alfalfa has been grown in the past. In the United States alone the area concerned amounts to about 800,000 square miles. Almost the sole reason for the absence of an alfalfa industry in this great area has been the lack of a variety adapted to endure great cold and other attendant adverse conditions.

In Grimm alfalfa it is believed that the basis of a successful alfalfa industry in this area exists. This strain is very much hardier than the ordinary kind obtained from Kansas, Utah, and elsewhere, and there is even strong reason to believe that it is the hardiest known form of the cultivated plant. It not only endures extremely low temperatures with or without snow and other untoward conditions, but it can be cut with safety later in the fall and will bear more abuse in the way of pasturage than any other kind thus far grown in comparison with it.

There are cases on record where Grimm alfalfa has borne temperatures as low as −38° F. with practically no snow covering without serious loss of stand. There is a small field containing possibly half an acre in Carver County, Minn., to-day more than 40 years old.

There is some disagreement among investigators as to how Grimm alfalfa attained its great hardiness, but there is no difference of opinion as to the fact that it is hardy. The evidence submitted in the present paper indicates that Grimm alfalfa came by its hardiness through selective acclimatization.

The foundation stock of Grimm alfalfa was brought to America in 1857. The uphill struggle which this strain has carried on can be more readily understood when we realize that common alfalfa, which was brought in from South America only three or four years before the Grimm, has extended itself over perhaps 5,000,000 acres, while the Grimm has covered less than 5,000 acres.

Grimm alfalfa came from the vicinity of the little village of Külsheim, near Wertheim, in the Grand Duchy of Baden, Germany. The winter months (December, January, and February) in this region are not quite as cold on an average as November in Minnesota, where Grimm alfalfa has now been grown over fifty years. A 35-year record exists for Wertheim. Only once in this time has a temperature of less than −20° F. been experienced. Only 13 of 35 winters have had temperatures below zero, while 22 have had minima ranging from 2° F. to 16° F. During the same years (1873–1907) St. Paul has never experienced a winter with a minimum as high as −10° F.

That Grimm alfalfa should suffer from winterkilling in its transfer from such mild to such severe conditions was inevitable. That it is still undergoing selective acclimatization is shown by the numerous experiments reported on in the present bulletin.

The region surrounding Grimm's old home and the adjacent parts of Wurttemberg and Bavaria have been for several centuries the chief seat of production of "alt-deutsche fränkische Luzerne," a variety highly prized in southern Germany because of its superior hardiness as compared with the French and other south European alfalfas. The writer has been fortunate in obtaining a number of samples of this old Franconian strain, one coming from within 6 miles of Wendelin Grimm's old home.

It is not possible to assert positively that "alt-deutsche fränkische Luzerne" is the progenitor of Grimm alfalfa, but it seems altogether likely that this is the case.

Nevertheless, it would be unwise to import seed directly from the original source, expecting that it would behave the same as the Minnesota-grown seed. In the nursery-row experiment at Dickinson, N. Dak., a row of Grimm alfalfa killed out less than 3 per cent, while an adjoining row of old Franconian alfalfa under conditions that might be termed absolutely identical killed out 75 per cent.

The great hardiness, and consequently the great potential value of Grimm alfalfa, has been amply substantiated by the investigations of the Bureau of Plant Industry and by the independent experiments of the Minnesota, South Dakota, North Dakota, and Montana experiment stations. Further corroboration exists in the experience of a considerable number of northern farmers, who have time and again planted seed of ordinary strains of domestic and foreign origin only to have their stands gradually deteriorate to a point where they were no longer profitable and had to be plowed up, and who have subsequently sown Grimm and obtained enduring stands.

It now becomes a matter of the greatest importance to propagate a sufficient supply of seed in order that Grimm alfalfa may be generally grown in the area where it is most valuable. Resistant as the strain is, it still suffers slightly in winters of unusual severity.

Only by determined effort can a successful alfalfa industry be established in our cold northern country. Farmers who have fields or plats of this strain should grow seed whenever possible, even if doing so sometimes causes a loss to them as compared with hay production.

Grimm alfalfa grown for seed should not be grown in close proximity to other tender sorts, as crossing goes on very freely and there is strong evidence for believing that the hardier strains are weakened thereby, and vice versa.

In his annual report for 1907 the Secretary of Agriculture predicted that the further extension of alfalfa growing on large areas is a prize that will be worth hundreds of millions of dollars yearly. With due persistence and an intelligent use of present knowledge, the North and Northwest can now begin to collect at least a part of their ultimate share of this prize.

PLATES.

DESCRIPTION OF PLATES.

Plate I. Fig. 1.—A field of Grimm alfalfa 25 to 30 years old on the Bender farm near Chaska, Minn. This shows partially the accumulated selective effect of the winters and other trying conditions which the field has endured. Not all of the plants are as old as the stand itself, a fact which is no doubt due to the thickening up of the stand brought about by seed that has fallen upon the ground from time to time and germinated. September, 1909. Fig. 2.—Winter resistance of Montana and Grimm alfalfa compared. The two plats shown in the foreground are both 2 years old. The one at the right is from seed grown in the Yellowstone Valley near Billings, Mont.; the one at the left is from Grimm seed originally produced in Carver County, Minn. These plats are on the Minnesota experiment station farm at St. Anthony Park. Photographed by Mr. H. D. Ayer, August, 1909.

Plate II. Fig. 1.—An 11-year-old field of Grimm alfalfa on the Kelm farm, near Excelsior, Minn. It retains from 75 to 80 per cent of the stand. The part of the field in the foreground shows third growth; that in the background, second growth, left for seed. September, 1909. Fig. 2.—A plat of Grimm alfalfa sown in rows 3 feet apart for seed production. The parent of the seed used on this plat was produced in Carver County in 1893, taken to Cottonwood County, Minn., about 150 miles distant, and seeded there in 1894. The original plat is still in existence, though it has produced seed about ten times in fifteen years. The stand has grown gradually thinner and was quite badly injured during the winter of 1902–3. The plat shown in the figure is at Dickinson, N. Dak., and suffered practically no winterkilling during the winter of 1908–9, when the many varieties in the experimental nursery marked by the white stakes in the near distance at the right showed a great range of injury. (For details of this experiment, see Bulletin 185, Bureau of Plant Industry, 1909.)

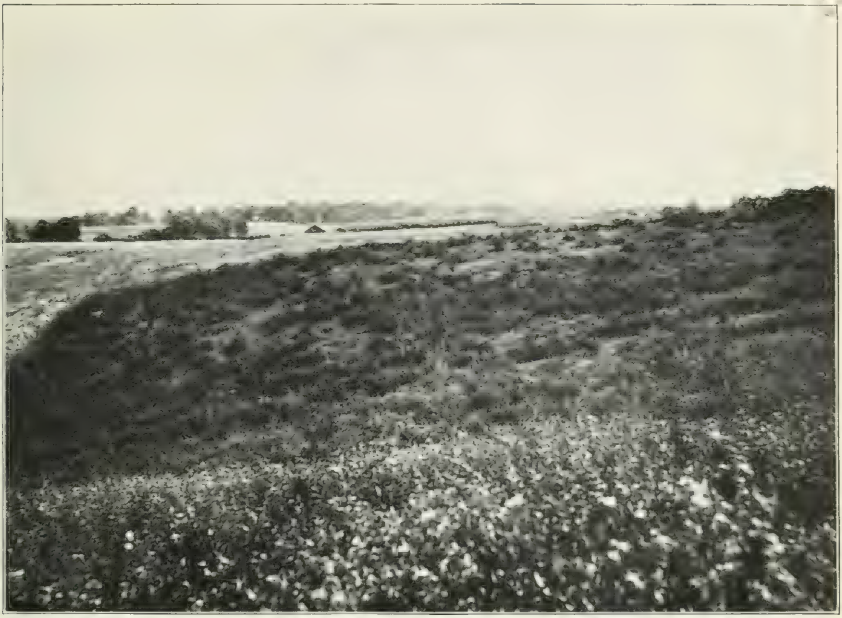

FIG. 1.—A FIELD OF GRIMM ALFALFA 25 TO 30 YEARS OLD ON THE BENDER FARM, NEAR CHASKA, MINN., SEPTEMBER, 1909.

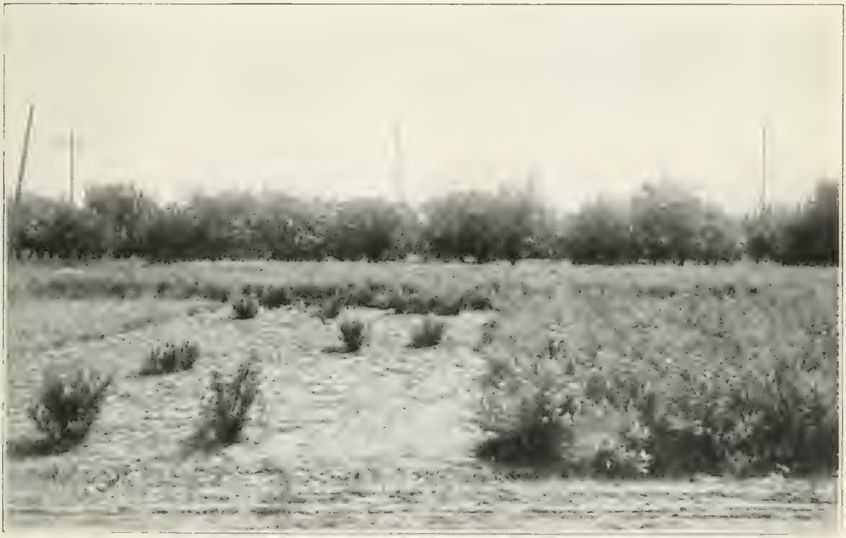

FIG. 2.—A 2-YEAR-OLD PLAT OF MONTANA ALFALFA (AT THE LEFT) COMPARED WITH STAND OF GRIMM ALFALFA OF SAME AGE (AT THE RIGHT), ST. ANTHONY PARK, MINN., AUGUST, 1909.

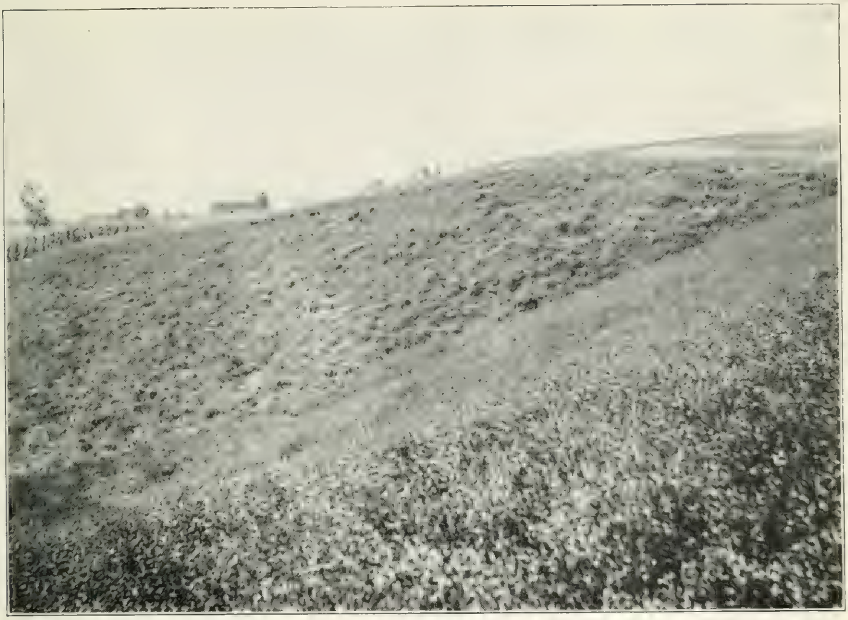

FIG. 1.—AN 11-YEAR-OLD FIELD OF GRIMM ALFALFA ON THE KELM FARM, NEAR EXCELSIOR, MINN., SEPTEMBER, 1909.

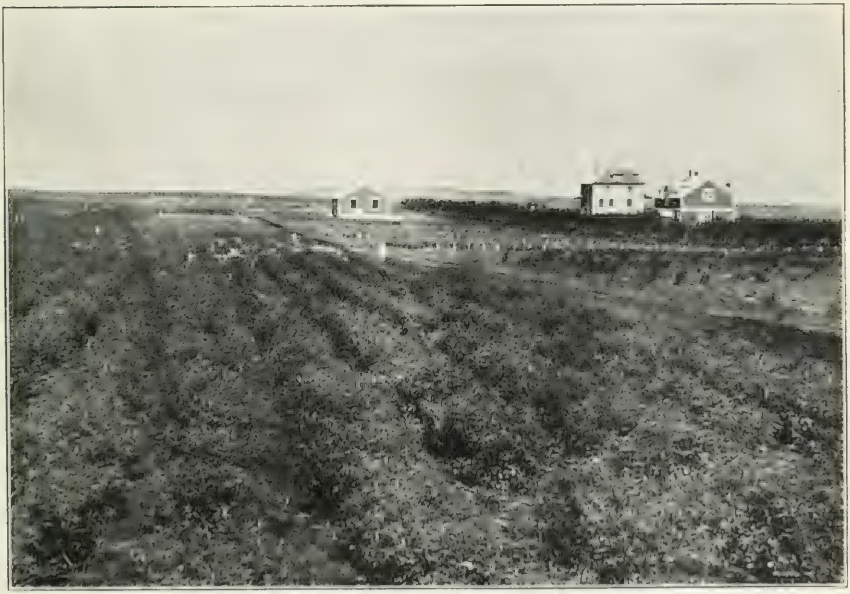

FIG. 2.—A PLAT OF GRIMM ALFALFA, SOWN IN ROWS 3 FEET APART, AFTER THE TRYING WINTER OF 1908-9, DICKINSON, N. DAK., JUNE, 1909.

In the nursery, whose location is shown by the white stakes at the right, 68 strains were winter-killed, an average of 78 per cent.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 210.

B. T. GALLOWAY, *Chief of Bureau.*

HINDI COTTON IN EGYPT.

BY

O. F. COOK,

Bionomist in Charge of Crop Acclimatization and Adaptation Investigations.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., January 13, 1911.

Sir: I have the honor to transmit herewith a paper entitled "Hindi Cotton in Egypt," by Mr. O. F. Cook, of this Bureau, and to recommend its publication as Bulletin No. 210 of the Bureau series.

This paper reports the results of a visit to the cotton-growing districts of Egypt in June and July, 1910. It shows that the admixture of inferior Hindi cotton is a serious burden upon the Egyptian industry and that our more intelligent farmers can secure an important advantage through the improved system of selection that has been developed by experiments in Arizona. A careful comparison of the results of the Arizona experiments with the conditions actually existing in Egypt became necessary in order to determine whether a satisfactory degree of uniformity has been attained in our acclimatized strains of Egyptian cotton. A previous study of the problem of diversity of the Egyptian cotton had been made in Arizona, as reported in Bulletins Nos. 147 and 156 of this series.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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HINDI COTTON IN EGYPT.

INTRODUCTION.

Inspection of many cotton fields in different parts of Egypt shows that the so-called Hindi cotton is a general contamination of the Egyptian stock, responsible for a large amount of diversity and degeneration. Expression of inferior Hindi characters renders many of the plants not only worthless from the standpoint of production, but dangerous to future crops. The establishment of a profitable culture of Egyptian cotton in Arizona and southern California depends largely on the exclusion of the Hindi contamination.[a]

The Hindi cotton complicates the problem of acclimatizing and adapting the Egyptian cotton to the cultural conditions found in the United States. In this case a problem of heredity had to be studied. Instead of the physical factors alone, it has been necessary to analyze the characters of the plants in order to determine the causes of impurity and find means of elimination.

---

[a] "Hindi is the name applied in Egypt to an undesirable type of cotton with a short, weak fiber, that injures the high-grade Egyptian varieties by infesting them with hybrids. The skill and cheapness of the native Egyptian labor enable the exporters to have the cotton sorted by hand in their baling establishments, so that a high reputation for uniformity has been secured in spite of the Hindi admixture.

"The introduction of the Egyptian cotton into the United States brings also the problem of the Hindi cotton, but without the resource of cheap labor which enables the difficulty to be surmounted in Egypt. The practicability of establishing a commercial culture of the Egyptian cotton in the United States depends largely upon the elimination of the Hindi contamination and other forms of diversity, so that the fiber may be produced in a satisfactory condition of uniformity. The Hindi cotton problem might be compared to that of the red rice that mixes with the white and depreciates the value of the crop. In the case of the cotton, there is a better prospect that adequate knowledge of the vegetative characters may enable the undesirable plants to be removed from the fields without too seriously increasing the cost of production." (See Circular 42, Bureau of Plant Industry, U. S. Dept. of Agriculture, entitled "Origin of the Hindi Cotton," 1909, p. 3. This circular contains the results of a previous study of the Hindi cotton made in connection with experiments in Arizona. It will be sent free on application to the Secretary of Agriculture.)

During the first years of its cultivation in Arizona the Egyptian cotton produced only small yields and rather inferior fiber. After the yield and quality began to improve, an undesirable amount of diversity appeared. A study of this diversity showed that it was due in part to hybridization with the common American Upland cotton, and that this danger was unusually serious in Arizona when the two kinds of cotton are grown in the same locality, owing to an unusual abundance of wild bees. The Hindi cotton is an additional factor of diversity inherent in the imported Egyptian stock, more difficult to understand because not previously known in the United States.

Experiments show that both of these sources of diversity can be eliminated by a more careful system of field selection, applied early in the season before the inferior plants have begun to flower, and hence before they have cross-fertilized the neighboring plants. The value of the Arizona Egyptian cotton and the prospects of cultivating this crop on a commercial scale in the United States depend largely on the degree of uniformity that can be attained in the fiber, in comparison with that of the Egyptian product. Hence, the necessity for an inspection of the cotton fields of Egypt in order to determine the extent of diversity in the crop as raised in that country.

The high cost of labor in the Southwestern States forbids any direct imitation of Egyptian methods, either in raising the crop or in preparing it for market. Other solutions of the problems of production have to be sought. The requirement of uniformity has been met in Egypt by a system of careful grading of the cotton after picking that would be very difficult to establish in the United States, and too expensive to leave any assurance of profit for the farmer even if it were established.

The Egyptian cotton trade is organized on an entirely different basis from the American. Instead of merely ginning and baling the farmer's cotton as he brings it from the fields, it is the regular practice of the Egyptian ginning establishments to buy the seed cotton from the farmer and prepare it for the market by sorting, grading, and blending. Instead of depending entirely on samples, as with American cotton, Egyptian cotton is sold largely by the marks or brands that are placed on the bales by the ginning establishments. Cotton of the same mark is supposed to represent a definite uniform quality. This is much more practicable in Egypt than it would be in most parts of the United States because of the much greater uniformity of climate and soil in Egypt.

In comparison with the wide range of soils, climates, and seasonal vicissitudes in the cotton-producing districts of the United States, the Egyptian cotton industry gives at first an impression of complete uniformity. Although people in Egypt supposed that cotton would be more advanced in Upper Egypt than about Cairo, this did not prove to be the case. It is quite possible that the crop of Upper Egypt comes to maturity earlier in the fall, owing to hotter weather in the summer, but there was very little difference at the middle of June. The effect that would naturally be expected from higher day temperatures in Upper Egypt may be neutralized in the early part of the season by cooler nights, due to the greater radiation allowed by the drier air. In any event the cotton was found at nearly the same stage of development about Beni-Suef as about Cairo and Tanta. (See Pl. I, fig. 1.) Even at the middle of July much of the cotton in Upper Egypt, between Beni-Suef and Minieh, was still quite small, having scarcely reached the flowering stage. In some fields the plants were only 6 or 8 inches high. The same was true of many fields in Lower Egypt in the region of Mansurah. (See Pl. II, figs. 1 and 2.) To what extent the later planting was responsible for the more backward state of the cotton in these districts was not learned, nor the reasons that may exist for later planting.

The most important local differences perceptible in Egypt were not those of the external conditions or of the methods of cultivation. The superiority of the cotton raised in the Delta region may be due in part to superior conditions, as generally assumed, but better knowledge of the Hindi cotton among the native cultivators is another factor of great importance, since it determines whether the inferior Hindi cotton shall be rogued out or left to mature in the fields. Many native cultivators at Beni-Suef pay no attention to the Hindi cotton, while about Mansurah it seems to be known to everybody. But even about Mansurah the human factor is by no means uniform, as shown by widely varying proportions of Hindi cotton in the different fields.

IMPORTANCE OF UNIFORMITY IN EGYPTIAN COTTON.

The requirement of uniformity increases with the presence of other good qualities of cotton. A long, strong cotton commands higher prices, because it can be spun into stronger or finer thread and used to make stronger or finer fabrics. An admixture of short, weak fibers not only reduces the strength of the threads and impairs the quality or durability of the fabric; it interferes also with the work of the spinning and weaving machinery by the more frequent breaking of the threads.

The superiority of the Sea Island cotton does not consist alone in its length and strength, but in its extreme uniformity. This is maintained by a highly developed system of selection, well recognized among the Sea Island planters but not yet applied to any other commercial type of cotton. The seed for each season's crop is raised by itself, apart from the general planting, and traces its ancestry back to a single superior individual of two or three generations before.[a]

In the Egyptian system of cotton culture no attempt seems to be made to imitate the methods of the Sea Island planters. Even less consideration is given to selection than in the Upland-cotton industry of the United States. While very few planters of Upland cotton have been accustomed to select their own seed, it has at least been possible for them to buy seed of selected stocks of many of the Upland varieties, whereas planters in Egypt do not appear to have any recognized source of supply from which to secure uniform stocks of seed of the Egyptian varieties free from the Hindi contamination. Differences between the seeds of the Hindi and the Egyptian cotton enable a selection to be made, even after ginning, but it seems evident from the condition of the fields in Egypt that a considerable quantity of Hindi seed must be planted and that many Hindi plants are allowed to grow to maturity and so to maintain the contamination.[b]

The advantage that the individual planter might gain by a careful and persistent selection of his own seed is difficult to realize under the Egyptian system of selling the seed cotton to the ginner. There is also a custom of exchanging seed between different villages on the theory that better yields can be obtained in this way. Thus growers of Mit Afifi cotton near Mansurah obtain their seed from Kefir Zeyat, between Tanta and Alexandria, a place that is commonly supposed to produce seed of a superior quality. Such exchanges of seed are well calculated to preserve and distribute the Hindi contamination. Even the introduction of new, carefully selected varieties could be expected to give only temporary improvement unless the whole system were changed. The process of deterioration would be resumed at once as a result of the crossing between adjacent fields of different varieties and the exchange of seed between different localities.

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[a] Webber, H. J. Improvement of Cotton by Seed Selection, Yearbook of the Department of Agriculture for 1902, p. 374.

[b] "The seed reserved for sowing is passed through special riddles, which remove small and dead seed; purity can not be obtained by this means, but merely a better looking sample; that is to say, as far as general appearance is concerned, the sample may be excellent, but closer examination reveals the presence of seed not true to variety. Small cultivators do not, as a rule, trouble even to secure the best seed which is procurable, but content themselves with the employment of that resulting from the ginning of common qualities of all pickings, regardless of origin and purity. Were this seed purchased at a low price it would provide no excuse for such a short-sighted policy, but even this is not the case, the price paid to the village merchant being, as a rule, considerably higher than that for which the better qualities could be obtained.

"In order to overcome this difficulty, the Khedivial Agricultural Society, in conjunction with the Agricultural Bank, distributes annually to small cultivators the best seed obtainable at cost price, the value of which is collected at the end of the following cotton season.

"It must be remarked, however, that the seed so distributed is merely the best that can be procured.

"That it is vastly superior to that which in the absence of such a system of distributing would be employed is without doubt. At the same time this system does nothing to actually improve the seed." (See Foaden, G. P., "The Selection of Seed Cotton," Yearbook of the Khedivial Agricultural Society, 1905, p. 122.)

After selection is relaxed the rapidity of deterioration of a variety of cotton depends on two cooperating factors, variation and crossing. Both of these factors must vary in different places, for they are influenced by external conditions. When cotton is grown under new or unfavorable conditions, more numerous variations appear. Abundance of bees or other cross-fertilizing insects causes a more rapid spreading of variations through the stock. Relatively uniform conditions and apparent scarcity of insects may give longer life to varieties in Egypt than in the United States, but the general tendencies and results of deterioration seem to be quite the same.[a]

The history of cotton culture in Egypt shows that a succession of new varieties has replaced the old at intervals of a few decades. The modern Egyptian cotton industry began with the variety discovered and popularized by Jumel, a French engineer, about 1820. The Jumel cotton was replaced by the Ashmuni after 1860, the Ashmuni by the Mit Afifi about 1890, and more recent varieties, such as the Jannovitch and Nubari, are now replacing the Mit Afifi. Other varieties, such as the Bamieh, Gallini, Zafiri, Abbasi, Sultani, etc., have either failed to gain any general popularity or have aroused only temporary interest.

LINT AND SEED CHARACTERS OF HINDI COTTON.

The character that renders the Hindi cotton so unwelcome as an element of admixture in the Egyptian stock is the much shorter and coarser fiber. The Hindi fiber is also pure white in color, whereas in the more popular Egyptian varieties the lint is a somewhat creamy white, tinged with buff or brown. White-linted varieties of Egyptian cotton have been cultivated to a small extent, but have never become popular in Egypt.

The difference in the color of the lint is of much assistance in the work of sorting out the Hindi admixture after the fiber has been picked and brought to the ginning establishment. Any thorough separation of the inferior Hindi fiber from a white variety must be much more difficult, if not entirely impracticable. From this point of view it is easy to understand why the culture of Sea Island cotton or of the superior white varieties of Egyptian, such as Abbasi, has not become more extensive.

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[a] Though very few insects were noticed in the Egyptian fields in June and July, they may be more abundant later in the season. Balls reports between 5 and 10 per cent of crossing, and even 25 per cent in one of his experiments. (See Balls, W. L., "Cross-Fertilization in Cotton," Cairo Scientific Journal, vol. 2, 1908, p. 405.)

The superiority claimed for the lint of the white varieties, such as Abbasi, is in accordance with other indications of a general correlation between the color and the length of the lint. Study of the lint characters of many variations and hybrids seems to indicate a general tendency in brown fibers to be shorter and coarser than white fibers. Thus the Jannovitch variety has lint longer and whiter than the Mit Afifi, though still with a very slight tinge of brown. The Abbasi lint is still longer, but is pure white in color.[a]

If the need of sorting the fiber were removed by more effective methods of eliminating the Hindi variations, the way would be open to a larger use of white-linted varieties. Though brownish lint is preferred for a few purposes, the color seems to be valuable chiefly for the aid it gives in sorting out the inferior fiber that results from the Hindi contamination. If American growers are sufficiently careful to keep out the Hindi contamination, they may be able to grow white varieties that have longer and stronger fibers than the brown-linted varieties now popular in Egypt.

In addition to the long fibers that compose the lint, the seeds of typical Egyptian plants are always provided with short fibers, or "fuzz," that continue to adhere to the seed after the lint has been removed by ginning. The fuzz may be confined to small tufts at the ends of the seed or may extend down one side, or may be more widely spread over the surface. The seeds of the typical Hindi cotton, on the other hand, are entirely without fuzz. The black surface is left entirely naked after the lint has been removed. The absence of fuzz makes the small, sharp-pointed, black stalk or funiculus at the base of the seed much more conspicuous in the Hindi cotton, though it is present in other varieties.

The seeds of the Hindi cotton are more angular in shape than those of the Egyptian cotton. Though not adhering like the seeds of kidney cotton, they seem to be more closely crowded together in the boll than the seeds of the Egyptian cotton, and this mutual pressure tends to make the Hindi seeds longer and more angular. Fully developed Egyptian seeds are usually plump, with all the sides distinctly convex and with a larger diameter than the Hindi seeds.

---

[a] The production of Abbasi cotton is said to be irregular because the price fluctuates with Sea Island cotton. When Sea Island cotton is cheap there is small demand for the Abbasi. Another variety that gave very promising results in an experiment in Arizona in 1909, the Nubari, is said to be not very highly appreciated in Egypt because of a tendency to produce small bolls. While many small-bolled plants were found in the Nubari field in Arizona, there was less diversity in this and other respects than in any other lot of plants grown from imported seed.

The smooth surface and narrower shape of Hindi seeds make it possible to separate most of them by sifting, as the Egyptian ginning establishments are said to do. Nevertheless, it is not to be expected that any complete elimination of the Hindi cotton can be accomplished in this way, for Hindi plants are occasionally found with fuzzy seeds much like the seeds of American Upland cotton. The seeds of Hindi hybrids are also somewhat fuzzy, often in the same way as the Egyptian seeds.

Hand selection of seed intended for planting is said to be done in Egypt, though it does not seem to be a regular practice. Experiments carried on by Mr. Argyle McLachlan in Arizona indicate that Hindi variations and other aberrant tendencies can usually be detected if the seeds are studied with sufficient care and discrimination.

The sorting out of the Hindi cotton is also assisted by the fact that the Hindi lint is very lightly attached, allowing the black surfaces of the seeds to be very readily seen. Even before the cotton is picked from the plants this difference is often very apparent.

In addition to being short and coarse, the fibers of the Hindi cotton are relatively straight and have very little tendency to cling together, like the longer and more abundant fibers of Egyptian and Upland varieties. After the Hindi bolls are open the seeds soon begin to separate and fall out, especially if they have a little assistance from wind or rain. In other words, the Hindi cotton is conspicuously lacking in storm-proof qualities.

The naked surfaces of the Hindi seeds may be responsible for the fact that young plants of the Hindi cotton often appear to make more rapid growth than adjacent Egyptian plants. Experiments have shown that the germination of fuzzy-seeded varieties may be seriously delayed in dry weather, while seeds without fuzz may germinate promptly in the same soil. Obviously, too, a Hindi seedling that had germinated promptly and had sent out roots to absorb water would retard the germination of other seeds in the same hill. The cotton is planted in Egypt in relatively dry soil, the young plants being easily destroyed by any excess of water. Under such conditions there is usually a very unequal development of the young plants. Two or three plants in each hill, or perhaps only a single one, may develop several leaves and attain a height of 8 or 10 inches, while the other seedlings of the same hill remain with only the cotyledons expanded.

DISTINCTIVE CHARACTERS OF HINDI PLANTS.

HABITS OF GROWTH OF HINDI COTTON.

If the Hindi cotton could be recognized only by the characters of the lint and seeds, it might be impossible to effect a complete elimination of the Hindi characters by selection. As long as Hindi plants are allowed to flower in the fields with the Egyptian plants and cross-fertilize them the undesirable Hindi characteristics may be expected to reappear. Even if no seeds of the Hindi form are planted, some of the apparently normal Egyptian seeds are likely to contain Hindi hybrid embryos, and these in turn can grow to maturity and produce pollen for continuing the Hindi infection to further generations. It is fortunate, therefore, that the Hindi cotton has several very definite differences in the vegetative parts, so that all Hindi plants can be recognized and rogued out of a field or a seed plat before the age of blooming and cross-fertilization is reached.

The general form or habit of growth of the Hindi plants is different from that of the Egyptian cotton, though this is not so apparent in the Egyptian fields, where the plants are crowded closely together, as in experimental plantings, where more space is allowed the individual plants. The tendency of the Hindi cotton is to produce a broader and more bushy plant, more like the Upland than the Egyptian cotton. (See Pl. I, fig. 2.)

There is a general impression that the Hindi cotton is larger and more luxuriant than the Egyptian, but this may relate to the Hindi hybrids rather than to the genuine Hindi individuals. The Hindi plants may appear larger early in the season, perhaps as a result of more prompt germination, but they are usually outgrown by the neighboring Egyptian plants by the time the fruiting stage is reached.

The Egyptian cotton, as well as the Hindi, shows different habits of growth under different conditions. In the cooler climate of Lower Egypt there is no such luxuriance of vegetative growth as in Arizona, but the branches are more spreading and the foliage more open. The habit of the Egyptian cotton in Egypt is more like that of Upland cotton in our Southern States. The similarity was especially strong in the Fayum Oasis, where some of the cotton is planted on rather poor land. It flowers and fruits when only 8 or 10 inches high, maturing small, bushy plants, like Upland cotton on poor soil in the South. Something of the exuberant tendency was shown in an experimental planting of Egyptian cotton at Siut (Assiut), in Upper Egypt.

The habits of branching of the Hindi cotton are also different from those of the Egyptian. The fertile branches are less definitely specialized than in the Egyptian cotton and have a stronger tendency to grow in upright or oblique positions and to assume the functions of vegetative branches, the flower buds being often aborted.[a]

LEAF CHARACTERS OF HINDI COTTON.

The leaves of the Hindi cotton are characterized by thinner texture and lighter color, a fresh, bright green that forms quite a definite contrast with the duller grayish or bluish green of the Egyptian leaves. The surfaces of the leaves of the Egyptian cotton are somewhat duller and more hairy in Egypt than in Arizona, though not so grayish as when the Egyptian cotton is grown in the cool climate of the Pacific coast, near Los Angeles. The color is usually darker before the fruiting stage of the Egyptian cotton is reached, when the foliage usually takes on a lighter and more yellowish tone. The dark foliage of the vegetative phase may be retained under conditions of abnormal luxuriance, or the change to the yellower shade of green may occur prematurely if the plants are affected by some unfavorable condition, such as too much water or too little.

The veins of the leaves of the Hindi cotton are usually reddish, and the red color becomes very pronounced at the pulvinus or cushion-like thickening at the bases of the veins, where they pass into the petiole or stem of the leaf. The two large veins on each side of the midrib are particularly likely to be grown together at the base, giving the pulvinus of the Hindi cotton an oblong shape. The leaves of the Egyptian cotton do not have an enlarged pulvinus, the veins passing more directly into the petiole without becoming much swollen or united at the base. The surface of the pulvinus of the Hindi cotton is naked, or with only a few scattering hairs, while the corresponding part of the Egyptian cotton is usually quite hairy.

The lack of specialization of the bases of the veins in the Egyptian cotton seems to render the leaves less capable of movement. They do not appear to change their positions to face the sun in the morning and afternoon as much as the leaves of the Hindi cotton. The turning of the leaves to the sun renders the Hindi plants more conspicuous in the morning and afternoon than in the middle of the day, when the leaves have a horizontal position. Advantage was taken of this fact in making inspections of fields from moving trains, as will be explained later.

Even in the first leaves or cotyledons of the young seedlings the reddening of the veins and the basal spot enables the Hindi cotton to be recognized and separated from the Egyptian. The difference of coloration is not so obvious in the first few leaves that appear after the cotyledons, for even in the Egyptian cotton these are likely to have a somewhat reddish spot at the base, especially if the conditions are not favorable for rapid growth. The differences become more obvious as the plants grow, until the flowering stage is reached, but they may lessen or disappear at maturity. In adult Egyptian plants the veins of the leaves often become reddish, while those of adult Hindi plants may become pale.[a]

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[a] Dimorphic Branches in Tropical Crop Plants. Bulletin 198, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910.

After the color contrasts have disappeared, the recognition of the Hindi plants requires notice of other less obvious details of the leaves, flowers, and bolls. Thus the leaves of the Hindi cotton have the lobes broader, more abruptly narrowed toward the apex, and usually produced into longer terminal points. In Hindi hybrids there are often 5 to 7 lobes which are often somewhat folded or plicate, as in the Egyptian cotton, the true Hindi plants having the leaves nearly flat. The rounded basal lobes of the leaf are broader in the Hindi cotton, so that the leaf as a whole is more nearly square or oblong in shape. The corresponding margins of the Egyptian leaves are likely to converge or slope backward toward the stem.[b]

The sinus or notch at the base of the leaf, where the petiole is inserted, is usually much broader in the Hindi cotton, exposing the upper surface of the end of the petiole. In the Egyptian leaves the sinus is generally very narrow or completely closed by the contact or overlapping of the margins of the lobes. The wider separation of the lobes of the Hindi cotton may be considered as a consequence of the thickening of the veins and the enlargement of the end of the petiole

FLORAL CHARACTERS OF HINDI COTTON.

The involucre that incloses the bud of the cotton plant is composed of three bracts, small leaf-like organs, each margined with a fringe of narrow teeth. The bracts of the Hindi cotton are more broadly rounded at the base and have longer and more numerous teeth than those of the Egyptian cotton. Comparison of the Hindi bracts shown in Plate III with the Egyptian bracts at the top of Plate IV will enable these differences to be understood. Another diagnostic feature of the Hindi bracts is that the teeth run down nearer to the base, a tendency that is shared by the Hindi hybrids. Three hybrid bracts are shown at the bottom of Plate IV. The bracts of the Egyptian cotton seemed to be somewhat more cordate in Egypt than in the United States, but the narrowly triangular form, straight sides, and small teeth, remote from the base, generally render them quite different from the Hindi bracts, in spite of endless variations in the minor details.

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[a] Mutative Reversions in Cotton, Circular No. 53, Bureau of Plant Industry, U. S. Dept. of Agriculture, March, 1910, pp. 10–11.

[b] For natural-size illustrations of leaves of Egyptian and Hindi cotton, see Circular No. 42, Bureau of Plant Industry, December, 1909, pp. 4 and 5.

The calyx of the Hindi cotton has five distinctly prominent triangular lobes, one or two of which are often produced into a narrow needle-like point. In the Egyptian cotton the lobes of the calyx are very short and broadly rounded, never produced into long points. Three examples of the toothed calyx of the Hindi cotton are shown in Plate III; an Egyptian calyx and the calyx of a hybrid in Plate IV.

The fresh, newly opened flowers of the Hindi cotton have pale creamy-white petals like those of Upland cotton instead of lemon-yellow petals like Egyptian cotton. In the afternoon the flowers of both sorts change to a reddish pink, but the Hindi flowers attain a much deeper shade than the Egyptian.

The petals of the Hindi cotton are shorter than those of the Egyptian and open more widely. The Hindi flower may be described as cup-shaped, the Egyptian as tubular.

The purple spot found at the base of each petal in Egyptian flowers is lacking or only faintly indicated in typical Hindi flowers, though often quite pronounced in Hindi hybrids.

The pollen of the Hindi cotton is of a much paler yellow and the individual pollen grains are much smaller than those of the Egyptian cotton.

FRUIT CHARACTERS OF HINDI COTTON.

The bolls of the Hindi cotton have a rounded conic shape, broadest near the base, and taper abruptly to a short point. Egyptian bolls are more fusiform, narrower at the base than near the middle, and taper less abruptly to a rather blunt apex. The shape differs appreciably with the conditions, the less luxuriant plants in Egypt having a broader and more conic form than is usual in Arizona, more like the bolls produced by the Egyptian cotton in the vicinity of Los Angeles. (See Pl. VI.)

The surface of the Hindi bolls has a rather dull pale pea-green color, with only slight indications of the deeply buried oil glands. Egyptian bolls, on the contrary, have a fresher, darker color, with the surface smooth and shining, but rather deeply pitted around the numerous superficial oil glands, each of which appears as a distinct black dot. These differences appear somewhat less pronounced in Egypt than in Arizona. Pale-green bolls were found on many plants that seemed in all other respects to represent true Egyptian cotton. The darker color of the bolls in Arizona may be connected with the greater luxuriance of the plants.

The number of carpels, or "locks," varies in the Hindi cotton from 3 to 5, the majority of bolls having 4 locks. In the Egyptian cotton the locks range from 2 to 4, with 3 as the prevailing number. Very few 4-locked bolls could be found in the Egyptian fields, but they are somewhat more numerous on the larger and more luxuriant plants grown in Arizona.

PREVALENCE OF HINDI COTTON IN EGYPT.

Familiarity with the vegetative characters of the Hindi cotton made it possible to secure definite information regarding the prevalence of this type of cotton in Egypt and thus obtain a basis of judgment regarding the value of the methods of selection that are being applied to the Egyptian cotton in Arizona. In attempting to judge of the practicability of establishing the culture of Egyptian cotton in the Southwest, it is obviously important to understand how far the commercial reputation of the Egyptian cotton for uniformity depends on the special methods of sorting and preparing the cotton for market. This will enable us to appreciate the advantage that may be gained by growing a more uniform fiber in the fields and avoiding the necessity of the subsequent labor in sorting and blending the fiber into a uniform product after it comes to the ginhouse.

Some writers have given the impression that the native cultivators rogue out all the Hindi plants during the process of thinning the young cotton early in the spring and thus avoid an admixture of the Hindi fiber. Others have referred to the Hindi cotton as a wild plant in Egypt, or even a common weed, making it seem almost impossible to avoid contamination.

Neither of these impressions seems to correspond with the facts. Though many of the native cultivators will hasten to assure the inquirer that they pull out all of the Hindi plants, a goodly remnant of typical Hindi individuals is to be found in nearly every field. On the other hand, one does not find the Hindi cotton, any more than the Egyptian cotton, outside of regularly planted cotton fields. Seeds scattered near permanent watercourses or about towns may sometimes grow to maturity, but it is not easy to understand how the idea of wild cotton growing at large in Egypt could have gained currency. Other plants that casual observers might mistake for cotton, such as the okra or bamieh (*Hibiscus esculentus*), the Deccan hemp (*Hibiscus cannabinus*), or even the cocklebur (Xanthium), are all strictly dependent upon cultivation and irrigation. It is difficult to believe that a plant of the habits of the cotton could exist as a native or truly wild species in the Nile Valley. And if such a species did exist naturally it would be dependent upon the annual flood for its water, and would be a winter-growing species. The commercial culture of cotton was not developed in Egypt under the historical system of basin irrigation direct from the annual flood of the Nile. The period of high water comes during the late summer and autumn, the fruiting season of the cotton. Egypt did not gain importance as a cotton-producing country until the modern system of perennial irrigation from stored water was developed, in the nineteenth century.

The Egyptian system of close planting greatly increases the difficulties of finding the Hindi individuals and of counting the Hindi and Egyptian plants to determine the percentages of each. Early in the season, while the plants are still small, each one can readily be seen as a separate individual, but with larger growth they fuse together, as it were, to form a solid mass of foliage. Early inspection has the further advantage of utilizing the differences in the color of the foliage that are readily appreciable in the vegetative phase of development, but tend to disappear after the fruiting stage has been reached, as already explained.

If actual countings are not made, the proportion of Hindi cotton is likely to be seriously underestimated after the plants have reached the adult or flowering stage. It has been said that the Hindi plants can be distinguished from the Egyptian by their taller growth, but this seems to be true of hybrids or of young individuals rather than of mature plants of the true Hindi type. It was noticed at Calioub and at several other points that while many of the hybrid plants ran several inches above their Egyptian neighbors, the true Hindi plants had usually been outgrown by the Egyptian. In fact, some of the Egyptian cultivators consider that the hybrids rather than the true Hindi plants ought to be pulled out. They have noticed that many of the large overgrown hybrids produce very little fruit and are willing to pull them out so they shall not crowd their more productive neighbors. Careful roguing in the early part of the season is more likely to take out all of the true Hindi plants and leave a few of the hybrids, so that careful cultivators are more likely to be familiar with mature hybrids than with mature Hindi individuals.

The true Hindi plants, being less obtrusive when the stage of maturity is reached, are very easily overlooked unless special care is taken to separate and count the plants of each hill. Though two plants are usually left at thinning, regularity in this respect can not be depended upon. It often happens that only one plant survives, or careless cultivators may leave occasional hills with three or four plants.

It may be that the value of countings as the basis of general estimates of the proportion of Hindi cotton would not be seriously impaired by assuming two plants to each hill. The saving of time in this way would enable more extensive counts to be made. This plan was followed in a few of the later countings mentioned below.

at Calioub and Siut, in fields where the plants had grown very large. The hills were each noticed in turn to see whether they contained Hindi plants. Hills with no Hindi were assumed to have two Egyptian plants. The general effect of this plan would be to reduce somewhat the apparent proportion of Hindi plants, since it is probable that in most of the fields there would be more hills with a single plant than with three or four plants. Nevertheless, it might be that the figures obtained in this way would be more reliable, in view of the larger areas that might be inspected in a limited time.

To serve as a general basis of judgment regarding the prevalence of the Hindi cotton in Egypt, countings of individual plants were made in several different localities. In most localities several separate counts were made, usually in fields of different proprietors, or at least of different tenant cultivators. The figures obtained do not represent the full extent of Hindi contamination of the stock, for in most cases a more or less careful roguing out of the Hindi plants had already taken place. The psychological factor of the individual cultivator enters, therefore, as an important element in the calculations. One field might have only a few Hindi plants, while the next would have a considerable percentage. Thus of two adjacent fields at Tanta one showed less than 3 per cent of Hindi, the other 15 per cent.

Questioning of the native cultivators showed wide differences of individual opinion. Some of them were quite alive to the need of pulling out all of the Hindi cotton and showed annoyance or offered excuses if reminded that many Hindi plants were still to be found in their fields. Others took a more languid interest in the matter. One cultivator might claim to have pulled out large numbers of Hindi already, while his neighbor might not think it necessary to admit any responsibility for pulling out the Hindi at all. He would not deny, perhaps, that he had heard of the need of pulling out bad cotton plants, but would insist that very few people did it.

The popular impression in Egypt among people who consider themselves informed about cotton growing is that selection receives proper attention in the Delta region, where the Mit Afifi and Jannovitch, the principal varieties of Egyptian cotton, are grown, but is very much neglected in Upper Egypt, where the Ashmuni and other inferior stocks are produced. It seems, however, that this impression may relate to more careful sorting done in the ginning establishments of the Delta rather than to any really efficient selection in the field. Even about Tanta and Mansurah, the recognized centers of production of high-grade fiber, a conspicuous representation of the Hindi cotton was seen in a large proportion of the fields.

The percentages of Hindi plants counted in fields at Tanta, in Lower Egypt, are about the same as those obtained at Beni-Suef, in

Upper Egypt. (See Table I.) The idea of Hindi cotton seemed to be more common about Tanta, but no indication of a serious effort to eradicate the Hindi type from the fields could be gathered from native cultivators. They are willing to pull out the Hindi plants rather than the Egyptian at the time that the hills are thinned down to the usual two plants, but have no idea of destroying any more plants after the thinning has been done. One very zealous native showed interest to the extent of pulling up some of the Hindi plants that were pointed out to him, where there was an Egyptian plant in the same hill. But when there were two Hindi plants together in a hill he would pull up only one. Nor could he be induced to sacrifice any of the Hindi individuals that stood by themselves, although he believed (as was afterward learned) that a Government inspection was being made. The Egyptian Government sends entomological inspectors through the fields to guard against outbreaks of the Egyptian bollworm.

Beni-Suef is considered the chief center of cultivation of the Ashmuni cotton, this variety being now confined largely to Upper Egypt. Inspection of fields in this locality on June 6, 1910, showed a general prevalence of Hindi and great lack of uniformity in other respects, though not as great nor as obvious as in experiments with this variety in Arizona. There is the same tendency to red spots at the base of the leaves, which is recognized as a mark of this variety to distinguish it from Mit Afifi, Jannovitch, and other more carefully selected varieties. The more general tendency to the red spot may be a result of a more general contamination with the Hindi type of cotton.

A special count was made at Beni-Suef to learn the extent of Hindi contamination as indicated by the presence of the distinct red spot at the base of the leaf. This included true Hindi plants, obvious hybrids, and all other plants that would have been considered as having too red a callus for varieties of Egyptian cotton other than Ashmuni. Of 213 plants examined for the color of the callus 133 had the callus green or only slightly tinged with red, as usual in Egyptian cotton, while 80 plants were noted as having the callus distinctly red, as in the Hindi cotton.

In the oasis of Fayum still less attention seems to be paid to the Hindi cotton than about Beni-Suef. Native cultivators knew that some of the plants produced inferior cotton, but did not claim to be able to distinguish them except by the white flowers. There was evidently no intention of pulling out any of the white-flowered plants. The variety planted at Fayum was not considered to be Ashmuni, but was merely called Beládi, or "native," cotton.

Other countings of Hindi were made in the Beládi cotton at Siut. Cotton is not regularly planted about Siut, but experiments are being made with seed brought from Fayum. The percentage of Hindi is much larger than appeared at Fayum, though the planter claimed that he had taken out numerous Hindi plants when the field was thinned. In addition to the plants counted as Hindi, much diversity was apparent, almost as much as in a field of Ashmuni cotton grown in 1909 at Somerton, Ariz. Such cases suggest the possibility that transfer to new conditions may have the effect of inducing additional variations in these diverse stocks, but the proportion of Hindi in either parent stock could not be ascertained. Whatever the cause of the phenomenon, it is a significant fact that the proportion of Hindi plants and obvious hybrids may run as high as 20 per cent.

The census of Jannovitch cotton at Tanta was somewhat more rigorous than that at Beni-Suef and included some plants with distinctly red leaf bases; plants with distinctly red leaves and other obviously aberrant tendencies that might have been omitted in the Ashmuni fields, where the red callus is so common a feature. But many other definitely aberrant plants with light-green leaves were not included when they lacked the red callus. These light-colored plants have the more ample and luxuriant foliage of the Hindi hybrids and may represent a second-generation splitting of the Hindi characters. Such a splitting might be expected with a color character like the basal spot that also shows seasonal reversibility.

The smallest proportions of true Hindi plants were found in fields in the vicinity of the barrage (a few miles below Cairo) and at Calioub, in the same district. None of the fields that were inspected in these places showed any large percentages. About two-thirds of the plants counted as Hindi were plants of the type considered as first-generation hybrids. In one field at the barrage and in another at Calioub no true Hindi plants could be found, even after a rather careful search, though several obvious hybrids were present in each field. At Benha, on the contrary, the Hindi percentages not only ran higher but a larger proportion of the plants represented the true Hindi type.

In the neighborhood where the counts were made near Mansurah the native cultivators placed much importance on the elimination of the Hindi plants, though they were known by a different name, "Haga," the word Hindi not being recognized. It was estimated that about 5 to 6 Hindi plants had been removed from each row of 100 to 150 plants at the time of thinning, in addition to those that remained to be counted. This would indicate a total Hindi representation of between 5 to 10 per cent in this stock of seed at the time of planting.

In several instances it was noticed that the Hindi plants seemed to be more numerous on the higher, drier ridges or dikes that bounded the different sections into which the fields were divided for irrigation purposes. Separate counts were made of plants along some of the dikes, but without securing any definite evidence. It would be interesting to know whether such differences of conditions would have an influence over the expression of the Hindi characters. Other explanations were possible—that the higher ridges had been neglected at the time of thinning the plants or that the Hindi plants had an advantage in germinating in the drier soil of the higher ridges, because of the smooth seeds. The cotton often appears to be more luxuriant on the higher dikes than in other parts of the fields. Indeed, such dikes are usually planted with double rows of cotton, as though to take full advantage of the more favorable conditions.

TABLE I.—*Countings of Hindi cotton plants.*

Location.	Plants counted.	Egyptian type.	Hindi type.	Percentage of Hindi.
Beni-Suef, Upper Egypt (Ashmuni variety)	445	435	10	2.24
	274	242	32	11.67
	512	457	55	10.74
	165	155	10	6.06
	178	161	17	9.55
	446	435	11	2.48
	327	294	33	10.09
	245	224	21	8.56
	130	124	6	4.61
Total	2,722	2,527	195	7.16
Tanta, Lower Egypt (Jannovitch variety)	595	569	26	4.36
	886	829	57	6.43
	464	441	23	4.96
	464	437	27	5.82
	368	340	28	7.61
	1,028	923	105	10.21
	806	738	68	8.44
	134	118	16	11.92
	566	550	16	2.83
	566	476	90	15.09
Total	5,877	5,421	456	7.77
Barrage, near Cairo	1,149	1,124	25	2.17
	424	410	14	3.31
	551	543	8	1.45
	483	474	9	1.86
	567	559	8	1.41
	334	328	6	1.79
	511	486	25	4.89
Total	4,019	3,924	95	2.36
Calioub, near Cairo	417	412	5	1.19
	497	493	4	.80
	1,216	1,202	14	1.15
	2,130	2,107	23	1.07
Fayum, Upper Egypt (Belādi variety)	871	819	52	5.99
	676	629	47	6.95
Total	1,547	1,448	99	6.41
Siut, Upper Egypt	609	494	115	18.88
	467	398	69	14.77
	316	260	56	17.72
	444	354	90	20.27
	467	383	84	17.98
Total	2,303	1 889	414	17.97
Mansurah, Lower Egypt (Jannovitch and Mit Afifi varieties)	844	829	15	1.77
	476	472	4	.84
	560	555	5	.89
	531	523	8	1.50
	790	758	32	4.05
	669	662	7	1.04
	528	517	11	2.08
	598	584	14	2.34
	934	924	10	1.07
Total	5,930	5,824	106	1.78
Benha, Lower Egypt	857	810	47	5.49
	202	200	2	.99
	461	429	32	6.93
	655	633	22	3.36
	558	542	16	2.86
Total	2,733	2,614	119	4.36
Beteha, Palestine	1,043	954	89	8.53
	889	816	73	8.21
	1,975	1,947	28	1.41
	982	946	36	3.66
Total	4,889	4,663	226	4.62

Count was made of 32,150 plants in all, of which 1,733 were recorded as belonging to the Hindi type, a percentage of 5.39. If the percentages for the different localities are averaged, a somewhat higher general average, 5.98 per cent, is obtained.

One series of countings of Hindi plants was made in an experiment with Egyptian cotton in Palestine, at a locality called Beteha, near the north end of the Lake of Tiberias, not far from the ancient Capernaum. The first two counts at Beteha were made in late-planted fields that had not yet been thinned or rogued for Hindi. The percentages obtained in these cases, 8.53 and 8.21, may be taken to represent the amount of Hindi contamination represented in the seed before planting. Early-planted fields at Beteha seemed to be as far advanced as any seen in Egypt, the date of the visit being June 23.

In order to obtain a more general and yet a not altogether indefinite indication of the prevalence of the Hindi cotton, the apparent presence or absence of Hindi cotton was noted for a considerable number of fields that could be seen to advantage from the railroad. Such inspection is greatly facilitated by a fact already considered, namely, that the leaves of the Hindi cotton have greater freedom of motion than those of the Egyptian cotton, and that they make pronounced changes of position in order to face the sun in the morning and afternoon. The Hindi plants are much more readily seen from a distance at these times than in the middle of the day, when the leaves are in a horizontal position to face the sun overhead.

The presence of tall hybrids gives a general impression of uneven surfaces to the fields and thus betrays the presence of Hindi cotton, even when details of individual plants can not be made out. But when the broader, fresh-green leaves of the Hindi plants are formed into rosettes to face the sun, they become conspicuous and unmistakable. Indeed, it is sometimes more difficult to distinguish them from the okra that is often planted in the fields than from the Egyptian cotton. The Egyptian okra (bamieh) has broad leaves of the same color as those of the Hindi cotton and also a red spot at the junction with the stem.

Such observations are greatly assisted by the fact that the Egyptian railroads are usually elevated on embankments. By being able to look down on the fields a more accurate impression can be gained than by viewing the plants from the side, as one is obliged to do when standing on the same level.

It is to be expected of course that Hindi plants would be found by more careful inspection in most of the fields where they were not apparent from a passing train. But at least it may be considered that fields showing no apparent Hindi have been rogued. In a large proportion of cases the Hindi plants and hybrids were very conspicuous. Fields that have had the Hindi plants and hybrids rogued out often appear remarkably even in height and color.

Such an inspection could not be made to any advantage after the Egyptian cotton has entered the fruiting phase, when the color changes from a dark to a lighter green, thus destroying the contrast with the Hindi cotton, so marked during the earlier vegetative phase.

In addition to the lighter color assumed by the foliage of the Egyptian plants as the season advances, the proportion of yellow in the fields is increased by the abundance of bracts and flowers. At the time these changes were taking place, about the middle of July, the dark-green tone of the vegetative phase was still shown with much uniformity in some of the fields, while others had gone over to the yellower shades or were still more completely dominated by the abundance of yellowish bracts and still yellower flowers. These changes seemed to have come rather suddenly, for most of the fields seemed to represent one phase or the other quite definitely, only a few showing pronounced individual diversities of coloring among the Egyptian plants.

TABLE II.—*Fields with Hindi cotton apparent from trains*

Fields were noted between towns—	Number of fields.	Fields with apparent Hindi.	Fields without apparent Hindi.
Calioub and Chebin el Kaneter	48	46	2
Chebin and Machetoul	53	50	3
Machetoul and Bilbeis	81	76	5
Bilbeis and Zagazig	82	81	1
Zagazig and Abou-Kebir	88	82	6
Abou-Kebir and Kafr Sakr	24	22	2
Kafr Sakr and Abou el Chekouk	30	24	6
Abou el Chekouk and Simbellaouein	51	[a](10) 44	7
Simbellaouein and Baklieh	13	(3) 13	0
Baklieh and Mansurah	24	(4) 17	7
Mansurah and Samanoud	90	(16) 73	17
Samanoud and Mehalla Kebir	29	26	3
Mehalla Kebir and Mehallet Roh	34	(4) 27	7
Mehallet Roh and Tanta	49	(3) 42	7
Total	696	623	73
Percentage		89.51	10.48

[a] In some localities fields that showed a strikingly large proportion of Hindi cotton were specially noted, and the numbers of such fields are given in parentheses in the table. It would be safe to estimate that the proportion of Hindi cotton and obvious hybrids in such fields was more than 5 per cent. Many fields between Bilbeis and Zagazig appeared to be quite as thickly sprinkled with Hindi as any in Upper Egypt where percentages of 15 and 20 were counted.

In addition to fields noted in Table II, many other inspections were made in the region between Cairo and Tanta. Several hundred fields were seen in Upper Egypt, in every one of which indications of Hindi contamination were found.

In the district between Abou el Chekouk and Mansurah much of the cotton at the middle of July was still too small and irregular to give favorable conditions for seeing Hindi plants from the train. Many of the fields had not begun to flower. In many the stand was irregular, or the plants of irregular sizes, perhaps as a result of alkali in the soil. Fields of rice interspersed among the cotton showed the same irregularity. The unfavorable conditions may be partly responsible for the larger proportion of fields with no apparent Hindi in this district. Fields with larger plants often showed great abundance of Hindi. Most of the cotton to the west of Mansurah was in better condition and afforded a more reliable indication of the prevalence of Hindi, or rather the prevalence of roguing. Though the proportion of fields apparently clean of Hindi seemed to be distinctly larger than in other districts, many of the fields showed unmistakable Hindi plants in great abundance.

Unless the conditions are favorable for the detection of the Hindi plants such inspections could have very little value, but if made at the right time the presence of the Hindi contamination and the relative amount in different districts could be judged very easily in all localities accessible by railroad. The time would differ with the growth of the cotton in the different localities, probably extending through the month of July. Before June 20 the Hindi plants could seldom be seen from the trains, but during the second and third weeks of July they were easy to see in all except the more backward districts.

CHARACTERS OF HINDI HYBRIDS.

DISTINCTIVE FEATURES OF HYBRIDS.

Except in cases that are especially noted, the plants enumerated as Hindi in the preceding tables comprise two elements, the typical Hindi plants and the pronounced Hindi hybrids, those that resemble the first generation of the crosses that have been made between the Hindi and the Egyptian cottons.

When the fields are in the earlier vegetative phase, the pronounced hybrids can be distinguished from the Egyptian plants by the light color of the leaves and the red pulvinus at the base of the veins, almost as easily as the true Hindi. The larger size of the hybrids also attracts attention. The leaves of the hybrids become larger than those of the true Hindi plants, and most of the larger leaves have five or seven distinct lobes instead of three. The lobes of the hybrids are somewhat folded or channeled, like those of the Egyptian cotton, instead of spreading out nearly flat, as in the Hindi cotton. The larger size of the involucral bracts of hybrids is another feature usually quite obvious. (Pl. IV, *B*.) The teeth do not always run down toward the base of the bracts, as in the Hindi cotton, though there is a general tendency in this direction. In Arizona the Hindi hybrids have shown a marked tendency to sterility or to very late bearing, but in Egypt, early in June, some of the hybrids seemed to be more advanced toward flowering than their Egyptian neighbors.

The countings of the Hindi plants and obvious hybrids do not by any means indicate the full extent of the Hindi contamination in the Egyptian fields. There is background of diversity too multifarious to be counted or even noted in detail without careful inspection of the characters of individual plants. Crossing between hybrid plants and Egyptian must produce many very dilute hybrids with little or no expression of the Hindi characters. Indeed, it may well be doubted whether any of the Egyptian stock would be found to be entirely free from the Hindi contamination if all of the ancestry could be traced. As yet we have no knowledge of the effects of slight dilutions of the Hindi blood upon the expression of characters, but experiments are being made to obtain information on this point.

Two principal elements might be recognized in the study of the diversity that exists in the Egyptian fields. One element might be ascribed to the prevalence of the Hindi cotton, the other to variation inside the Egyptian type. But in the present state of our knowledge it is often quite impossible to determine at once whether a variant plant is a dilute Hindi hybrid or an unusual example of the Egyptian stock. Evidence on this question can be secured by planting the seed to see whether the progeny "come true" to the characters of the parent, as in a mutation, or show more pronounced reversions to the Hindi type. But many mutative variations are also to be considered as reversions. The practical fact is that the Hindi contamination is responsible for a large amount of diversity outside of the obvious hybrid forms that resemble first-generation crosses.

Among the plants enumerated as Egyptian are many that are appreciably different from the Egyptian type, even in the early part of the season. Without departing seriously from the Egyptian form and habits of growth, some of the plants have broader or narrower leaves, lighter or darker than their neighbors. Though the form of the leaves may be that of the Egyptian cotton, the bases of the veins may be reddened as in the Hindi. Or plants with Egyptian foliage may have unusual habits of growth, the more frequent tendency being toward taller stalks and more strictly upright branches.

The large cordate bracts that characterize the most obvious Hindi hybrids are not entirely confined to that class of plants, but may be found on other large plants with foliage of Egyptian shape and color. The pulvinus may have the Hindi size, shape, and color, though concealed by more abundant hairs. In addition to the large circular, or very deeply cordate bracts, with the teeth running well down, such plants often have the calyx distinctly toothed, though the teeth do not have the long slender points that occur so frequently in the Hindi cotton. (See Pls. III and IV.)

As the season advances such differences become more apparent. When flowering and fruiting begin the hybrid nature of many individuals becomes unmistakable, even in plants that might not have been suspected of hybridity from the vegetative characters alone. Roguing must not be limited to the time of thinning in the early spring if any complete elimination of the Hindi characters is expected.[a]

The tendency to revert to small bolls is one of the most frequent and least obvious evidences of Hindi contamination. Small bolls can often be found on large-bolled plants, but many individuals produce only small bolls. The shape of the bolls may not suggest Hindi, though other Hindi characters may be found, such as naked seeds, sparse white lint, or pale spots in the flowers.

To make a complete enumeration of all the plants that show any of the Hindi characters it would be necessary to watch a field of cotton through the whole season, for in some plants only the lint and the seeds may betray the Hindi ancestry. Already, at the beginning of the fruiting season in Egypt, it became evident that many of the aberrant Egyptian plants were really Hindi hybrids, in addition to the type of hybrids that had been included in the countings. Even in the fields that had been quite carefully rogued, as at Mansurah, so that only very small percentages of plants with the Hindi foliage were left, many white-flowered individuals remained. The leaves of the white-flowered plants seemed to be a little broader than those of adjacent yellow-flowered Egyptian plants, but the difference was not enough to be noticed if attention had not been attracted by the flowers.

COHERENCE OF CHARACTERS IN HYBRIDS.

It is not yet certain that all of the more Hindi-like hybrid plants are really first-generation hybrids, the direct result of cross-fertilization between Hindi and Egyptian plants. All that is known at present is that the crossing of Egyptian with Hindi does produce plants of the Hindi-like hybrid type. The experiment has been made in Egypt by Mr. Balls and in Arizona by Messrs. McLachlan and Meade. It is possible, however, that some of the Hindi-like hybrid forms may represent the progeny of hybrid parents. According to the Mendelian theory of heredity a part of each generation of hybrids should resemble the first generation, while the remainder should show other combinations of the parental characters. In typical Mendelian hybrids the contrasted parental characters are supposed to have entire freedom of chance combination in the second and later generations.

In reality there does not seem to be such complete freedom of combination of the two sets of characters that represent the two parental types. Plants that have the Hindi foliage, or that of the Hindi-like hybrid type, invariably have the white petals of the Hindi cotton.

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[a] Cotton Selection on the Farm by the Characters of the Stalks, Leaves, and Bolls, Circular No. 66, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910.

White flowers always have the more open, cuplike form of the Hindi cotton instead of the longer and more tubular form of the Egyptian cotton. It very rarely if ever happens that any single Hindi character is brought into definite expression by itself—that is, without being accompanied by the more or less definite expression of other Hindi characters. It is hardly to be supposed that any of the Hindi plants, any more than the Egyptian, are pure bred in the sense of having had no Egyptian ancestors, and yet the Hindi type is nearly as uniform as the Egyptian, in spite of all the selection that has been directed against it. Neither is it reasonable to assume that all of the pronounced hybrid plants have the same proportions of Hindi and Egyptian blood, though they form nearly as definite a group as the parent types.

Hindi-like lint and seeds sometimes occur on plants that give little or no external evidence of Hindi contamination, but plants that have previously shown Hindi leaves or flowers very seldom, if ever, have typical Egyptian bolls or lint of good Egyptian quality. In a field of Jannovitch cotton raised in Arizona in 1909 from imported Egyptian seed numerous individuals were found that seemed, early in the season, to depart from the normal Egyptian type only in the lighter and more pinkish tinge of the purple spot at the base of the petals. But when these plants were examined again in the fall it was found that the bolls and lint also departed from the type of the variety. All the pale-spotted individuals had small bolls, and some of them showed naked seeds and short Hindi-like lint.

That the depth of color of the petal spot can be, in itself, a matter of any direct significance in the economy of the plant is hardly to be believed, but it seems to have an indirect significance as indicating a tendency for the Hindi or other abnormal characters to come into expression. White petals may be considered in the same way as evidence of a still stronger tendency to express the Hindi characters in the parts to be subsequently formed. Very pale yellow flowers were noticed on a few Egyptian-like plants at Mansurah, but in nearly all cases a departure from the normal Egyptian color involved a complete change to the creamy white of the Hindi flowers.

Although white Hindi-like flowers are rarely to be found on plants that have produced Egyptian foliage, such sudden changes in the expression of the characters do not appear to be normal phenomena of heredity, at least in cotton hybrids, for plants with these incongruous combinations of characters are generally infertile and sometimes completely sterile.[a]

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[a] Mutative Reversions in Cotton, Circular No. 53, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910, p. 6.

Coherence of characters is not confined to Hindi hybrids, but apparently has to be reckoned with in any attempt to combine the characters of different types of cotton. The phenomenon was first recognized and described in the study of Egyptian-Upland hybrids in Texas and Arizona. It differs from correlation in affecting whole groups of characters instead of only two or three. Thus a general correlation may be said to run through many different types of cotton—between the shape of the boll and the length of the lint or between the color of the lint and its strength. Correlation refers primarily to the fact that certain characters tend to vary together, one increasing or diminishing in relation with another. The fact that the weight of ears of corn increases with their length is reckoned as a correlation. Coherence refers to the expression of characters in hybrids. It denotes a condition in which characters derived from the same parent remain together in expression instead of being expressed in chance combinations as in Mendelian hybrids.

Correlations often appear entirely arbitrary, unless they are merely mathematical expressions, as in the case of the corn ears. From the mathematical standpoint it seems impossible to understand why long fibers should not be packed into round bolls as well as into pointed bolls or why brown fibers should not grow as long as white fibers. But after the tendency to coherence of much larger groups of characters has been recognized as a fact correlations appear somewhat less mysterious. The general association of longer lint with more pointed bolls in any particular type of cotton may be connected with the other general fact that the long-linted types of cotton have more gradually tapering bolls than short-linted types of cotton. Coherence implies that the expression or nonexpression of one character may determine whether other characters shall be patent or latent.

A striking example of coherence of characters was observed in Egypt in a block of hybrids made by Mr. F. Fletcher, director of the School of Agriculture at Gizeh, between an American Upland variety called Jackson's Limbless and an Egyptian variety called Voltos, somewhat similar to Nubari, Voltos being the male parent. In addition to many other courtesies of hospitality Mr. Fletcher most generously insisted upon a full use of his interesting series of experimental plantings of cotton at Gizeh, which yielded many interesting facts with special relation to problems of diversity.

Instead of the usual tendency of some of the Egyptian traits to predominate in the first generation, this lot of hybrids showed an unusually definite expression of the Upland characters. Very few of the plants would have been taken for Egyptian cotton, even on casual examination, and none of them showed any close approximation to the Egyptian type. On the other hand, a considerable proportion of the plants adhered very closely to the characters of the

Upland type. Several of these were distinctly clustered and some were quite limbless, like the Upland parent, though the majority did not have the shortened internodes.

Coherence of characters was shown very conspicuously in the fact that all of the definitely clustered or limbless plants had the Upland type of foliage, all were quite hairy, and all had white petals, as in Upland cotton. The only definite mark of hybridization on several of these plants was the purple spot at the base of the petals. When the purple spot was lacking there was no definite evidence of hybridization, but some plants that would have been taken for pure Upland in all other respects had very faint spots, showing that they were hybrids.

There was no complete dominance of the yellow flower color as reported in some Egyptian-Upland hybrids. None of the yellow flowers were as yellow as those of Egyptian cotton. All of the yellow flowers had pale-purple spots at the base of the petals. Some of the white flowers had spots as dark as any of the yellow flowers. In this respect the hybrids may be said to afford an example of the Mendelian law of free combination, but these variations occurred in the first generation, where Mendelian crosses are expected to give more uniform results.

Another lot of hybrids produced by Mr. Fletcher by fertilizing an Upland cotton from Cochin China with pollen of the Voltos variety of Egyptian cotton showed quite a contrast in comparison with the preceding series. Nearly all of these plants looked like ordinary first-generation Upland-Egyptian hybrids, except one that showed only Upland features. But the white petals had small purple spots as an evidence that the plant represented a true hybrid, not merely a result of accident in manipulation. The plant was very hairy and the leaves and bolls showed no departure from Upland characters. All other plants of the cross had pale-yellow flowers, and all the flowers had the spots pale, sometimes entirely wanting. The spot character would have to be reckoned as nearly recessive, but not quite completely so. Two plants were found in the same lot that might have been taken for ordinary Egyptian individuals, unless it were for too much hair, but one plant was more hirsute than the other, especially on the under side of the leaves, where the stellate hairs developed into noticeable tufts. This also must be taken as a sign of hybridity. The other plant was somewhat abnormal, in that it produced several sterile involucres composed of only a single bract.

In a third lot of hybrids between the Voltos variety of Egyptian cotton as the female parent and the Cochin China Upland as the male there were several more plants of a complete Upland type. Three of these plants had been grown from fuzzy seeds that appeared in the Voltos cotton, an indication that the variety was not pure.

The habit of these plants was much like the Cochin China parent and also closely similar to that of the Rabinal and Pachon varieties of Upland cotton from Central America. The plants were very hairy and the bracts were unusually well closed, as well or better than in the Rabinal cotton, and being also larger they remained closed to a more advanced stage. This character of the closed bracts was also shown among the hybrids. It was fully expressed, or even intensified, in some of the plants that had yellow flowers and other unmistakable evidences of hybridity. Well-closed hairy bracts have value as a weevil-resistant character, since they exclude the insects from the young buds.[a]

The phenomenon of coherence of characters is not only of interest from the standpoint of the scientific study of heredity, but is of distinct practical importance in relation to the problem of developing and maintaining uniformity in cultivated varieties. It represents on the one hand a limitation of the power of the breeder to make free combinations of the characters of different species, as in ordinary Mendelian hybrids, but on the other hand it assists in maintaining the uniformity of established strains and guarding them against contamination. If there were no coherence in the expression of the characters any Hindi character could come into expression independent of any other. The work of selection would involve a detailed inspection of each plant by all of its characters and would require an amount of time that would make it entirely impracticable as a farm operation, even though the farmer should acquire the necessary skill. In short, it is the fact of coherence of characters that lends value to selection, that makes it possible by roguing to improve or maintain the quality of the crop.

The success of the Egyptian method of securing commercial uniformity by matching the color of the fiber rests also on the fact that variations in the color of the lint are not independent of other characters. The inferior lint of the Hindi plants and hybrids does not have the same color as the lint of Egyptian plants. If there were no coherence of the Hindi characters the brown color would be found in combination with the naked seeds and short lint of the Hindi type, but this seems never to occur.

Recognition of the principle of coherence calls attention to the practical fact that plants seldom make serious changes in the expression of one character without showing changes of expression on other characters. The plants that produce the inferior lint in the fall are those that have departed from the regular courses of development earlier in the season. Indeed, these departures from normal heredity can usually be recognized much more readily by inspecting the vegetative characters of the plants in the earlier stages of development than after the crop is ripe and the damage of cross-fertilization has been done. It takes only an instant to see that the foliage or the habits of growth of a plant are different from those of its neighbors, much less time than is required to judge plants by their lint and seed characters at maturity, after the external differences of leaves, flowers, and bolls are no longer to be appreciated.

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[a] Weevil-Resisting Adaptations of the Cotton Plant, Bulletin No. 88, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1906.

The breeder in search of new varieties may find it desirable to preserve all the sports or freak plants that he can find to see whether in some rare cases they may not prove superior to normal plants of the variety, but the farmer who follows this course will lead his variety to degeneration. He must rely on the fact that the vast majority of the plants that diverge from the characters of the variety represent degenerations. His policy is to pull all the aberrant plants as soon as they can be detected. If allowed to remain, they will destroy the uniformity of the stock.[a]

INTENSIFICATION OF CHARACTERS IN HYBRIDS.

Another deviation from the Mendelian expression of characters in cotton hybrids is found in cases where characters are suppressed or intensified beyond the range of variation of the parental types. The crossing of the Egyptian cotton with short-staple Upland varieties usually results in a favorable intensification of the lint characters in the first generation. Notwithstanding the inferiority of the lint of the Upland parent, the lint of the hybrid is usually longer and stronger than that of a pure Egyptian progeny grown under the same conditions.[a]

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[a] A writer in the Liverpool Daily Post and Mercury (Saturday, March 12, 1910) maintains that periods of prosperity for the Egyptian cotton industry have followed the introduction of new varieties and that periods of depression ensued as the varieties degenerated:

"It is to be remarked that each time a new variety of seed was sown for the first time of cultivating an increase was immediately obtained of 1 to 1½ cantars weight per feddan, and as high as 12 to 14 per cent in the ginning yield. This increase diminished with the passing years and by slow degrees the seed degenerated. The excellent results of the beginning did not bear out their early promise, and after a lapse of time of more or less duration the seed cultivated had to be abandoned to give place to a new variety. * * *

"And it is the same story. As in 1862, when the Jumel, old and degenerated, had to be abandoned, as in 1892 the Ashmuni had to be replaced by Mitaflifi, so to-day the Mitaflifi seems coming to the end of its career, and no one can deny the degeneration of quality.

"While in 1891, 1892, and 1893 it yielded 7 to 8 cantars per feddan on the best lands and 5 to 6 on the others, at the present day it never gives either 7 or 8 cantars, and in Lower Egypt its production has certainly diminished by 1 to 1½ cantars per feddan on an average. This cotton, which during the first years of its cultivation yielded 110 to 114 in ginning, no longer gives to-day more than 101 to 103, and that with difficulty. * * *

"Seventeen years, therefore, had sufficed for the degeneration of Jumel, and it is exactly after the same lapse of time that we are forced to notice the degeneration of Mitaflifi."

A form of intensification occasionally shown in Egyptian-Upland hybrids is an unusual development of the nectaries. An excellent example of this was found in an aberrant plant at Calioub, July 12, 1910. It was probably a Hindi hybrid, though showing no pronounced Hindi characters. It was much taller than its neighbors and had unusually long basal internodes on the fruiting branches, while the other internodes were short and imperfect. Many buds had aborted and no bolls had been set. Each of the involucres that remained on the plant, 15 in number, had a large nectary on each of the three bracts.

In order to give a more definite indication of the extent of intensification shown by the nectaries of this plant, notes were made of the occurrence of nectaries on the involucral bracts of six adjacent plants, one of which happened to be Hindi. The lower buds of the Egyptian plants were generally without nectaries, unlike the Hindi plant which had nectaries on the early as well as on the later involucres, though with no such regularity as in the aberrant plant, to say nothing of the much larger and more regular size of the nectaries of the aberrant plant. Table III shows the distribution of nectaries on all the involucral bracts of the Egyptian and Hindi plants. Bracts with large nectaries are indicated as "N," those with small nectaries as "n," those with no nectaries as "o." No nectaries as large as those of the aberrant plant were found on any of the neighboring Egyptian and Hindi individuals. Several other plants were examined in addition to those that were definitely counted. One of the Egyptian plants had an involucre with only two bracts, a not uncommon occurrence.

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[a] Suppressed and Intensified Characters in Cotton Hybrids, Bulletin 147, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1909.

TABLE III.—*Census of nectaries of Egyptian and Hindi cotton plants.*

Adjacent plants.			Aberrant plant.	Adjacent plants.		
Egyptian.	Egyptian.	Egyptian.		Hindi.	Egyptian.	Egyptian.
o n o	o n n	o o o	N N N	o o o	o o o	o o o
o o o	o o o	o o o	N N N	o o o	o o o	o o o
o o o	n n n	o o o	N N N	o n n	o n o	o n o
o o o	n n n	o o o	N N N	n n o	o o o	o o n
		o o	N N N	n n o		n o o
		o o o	N N N	o o o		o n n
		o o n	N N N	o n o		o o o
		o n n	N N N	o o n		o o o
		n n n	N N N	n o n		o n n
		o o n	N N N			
		o n o	N N N			
			N N N			
			N N N			
			N N N			
			N N N			

Another example of a notable departure from parental characters was shown in a block of hybrids produced by Mr. Fletcher by crossing two Egyptian varieties. The whole block showed a remarkable susceptibility to a disease of the roots similar to the wilt of the United States. The whole block of plants was notably different in behavior from either of the three other blocks of hybrids that inclosed it on three sides: the other side bordered on a roadway. All of the plants were small, with a very open habit of growth, and their foliage was tinged with red. Many of the roots were dead or dying and had changed to a grayish-brown color. The contrast between this block and its neighbors was very distinct out to the square corners, with the larger and more healthy plants on either side.

Microscopical examination by Mr. Fletcher found the fibro-vascular bundles of the roots stuffed with fungous mycelium. There seemed to be no escape from Mr. Fletcher's view that this particular stock of hybrids was unusually susceptible to the disease in comparison with the surrounding stocks. The peculiarity may have come, of course, from one of the individual plants that happened to be used as parent of the cross, but this does not diminish the value of the evidence that some members of the Egyptian type may have marked susceptibility to the disease. Mr. Fletcher has noted other indications of such susceptibility and is inclined to believe that the disease may be an unrecognized cause of much damage to the crop. It appears that the symptoms are generally more pronounced on land that had cotton the year before, but the observations have not extended far enough to establish this point.

RELATIONSHIPS OF HINDI AND EGYPTIAN COTTONS.

The Egyptian cotton in the United States is exposed to the additional danger of crossing with the American Upland type of cotton. It is quite as important to guard against this danger as to exclude the Hindi contamination that has caused so many difficulties and losses in Egypt.

Experiments indicate that the result of allowing the Egyptian cotton to be crossed with Upland pollen will be much the same as with the Hindi, and this is also to be expected from the fact that the Hindi cotton shares many of the characters of Upland cotton, and especially those of some of the types of Upland cotton that have been discovered recently in southern Mexico and Central America.[a]

Though differing in minor details, there is a general agreement between the American Upland types of cotton and the Hindi in the habits of growth, the form, color, and textures of the leaves, involucres, and flowers. The external characters of the bolls are also much the same. The principal difference lies in the character of the seeds. In the American Upland cottons the seeds are generally covered with a dense coat of short fuzz, though some of our varieties show frequent variations in the direction of naked seeds, like those of the Hindi cotton. Indeed, there are occasional variations where the lint and the fuzz are both lacking, showing that the seed characters of the Hindi cotton lie within the range of variation of the Upland type. Thus if the parentage of a hybrid plant is not known it may be impossible to determine whether it represents the Hindi contamination or an Upland cross. In general it may be assumed that plants with hairy stems and leaves represent Upland hybrids rather than Hindi, for the typical Hindi cotton is not hairy. Yet a few hairy Hindi-like plants have been found in Egypt as well as in plantings of imported seed in Arizona.

From the standpoint of the study of heredity it would be very desirable to determine when the Hindi contamination of the Egyptian cotton took place. The Hindi variations may represent a recent admixture or the crossing may have taken place so far back as to represent a general constitutional tendency to reversion pervading the whole Egyptian type. The idea that the Hindi cotton grew as a wild weed in Egypt would allow us to suppose that the process of contamination had been continuous, with some new crosses every year to replace those that were removed by selection. But the idea of wild cotton in Egypt and also the theory founded upon it seem altogether improbable. The sources of the Hindi contamination must apparently be sought farther back.

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[a] Origin of the Hindi Cotton, Circular No. 42, Bureau of Plant Industry, U. S. Dept. of Agriculture.

Another possibility is that the Hindi cotton was formerly cultivated in Egypt before the present so-called Egyptian type was introduced and that the mixing occurred while the Egyptian cotton was replacing the Hindi. A difficulty with this idea is that the lint of the Hindi cotton is so sparse and short as to make its cultivation seem improbable. But it is possible that Hindi plants now appearing as reversions among the Egyptian cotton do not fully represent the possibilities of the Hindi type in the direction of lint production. While there is a general tendency to sparse lint among naked-seeded types of cotton, this is not universal. A strain of Caravonica cotton grown in Hawaii has very abundant lint, in spite of the fact that the seeds are entirely devoid of fuzz, as shown by samples recently deposited with the Department of Agriculture by Dr. E. V. Wilcox. Director of the Hawaii Agricultural Experiment Station. Mr. Fletcher has recent information indicating that Hindi cotton is still planted as a crop in Mesopotamia under the same name as in Egypt. Plants grown at Gizeh by Mr. Fletcher from seed received from Mesopotamia were carefully examined and seemed to show all the essential characters of the Hindi cotton. (See Pl. III.) It is possible, therefore, that the Hindi admixture may be traced by way of Mesopotamia.

The idea that the Mediterranean countries were limited to Old World types of cotton (*Gossypium herbaceum*, and its relatives *indicum*, *arboreum*, etc.) even in ancient times may prove to be erroneous. In southern Italy an Upland-like cotton is cultivated under an ancient name "*bombage*," evidently cognate with the Greek "*bombax*." The plants are quite small and somewhat hairy, like American Upland cotton, but the bracts are very strongly toothed after the Hindi fashion.

In this connection it may be well to mention the fact that a sample of seed of brown, rough-fibered cotton has recently been received from northern Arabia by the United States Department of Agriculture. While these seeds and lint do not closely resemble those of any recognized variety, they show more of an approach to the Egyptian qualities than any samples previously seen from the Old World. Another small sample of seeds and lint, received about the same time from Honduras, has a much closer resemblance to the Egyptian cotton and is stated to represent a native tree cotton. These seeds have the size and shape of Egyptian seeds with tufts of brownish fuzz at the ends, and the lint is similar to that of the Egyptian cotton, whereas the seeds from Arabia are covered with a brown fuzz.

While at Gizeh there was also opportunity, through the kindness of Mr. W. Lawrence Balls, botanist of the Khedivial Society, to see living plants of a kidney cotton raised from seed brought from the Niam-Niam country in the upper valley of the White Nile, a type considered by Mr. Balls as representing one of the parents of the Egyptian cotton. It has to be admitted that these plants show a notable agreement with the Egyptian cotton in many respects and are quite unlike any of the varieties of kidney-seeded cotton that have been seen in Mexico and Central America or received from those countries.

The Niam-Niam cotton has three external nectaries present with great regularity, reniform-cordate in shape, and usually distinctly emarginate on the upper side. The nectaries are always of a red color, at least on these well-exposed plants. Inner nectaries are also present with much regularity, are broadly V shaped, and often colored red. The surfaces of the nectaries are rather coarsely granular-papillate and without hairs. Cases of supposed intensification of nectaries in Egyptian hybrids might be considered as reversions to such an ancestor as this.

The leaves vary from entire to 5 lobed, the latter usually on the rank growth of new shoots. Occasionally there are 6 or 7 lobes, but the additional lobes are usually small. The leaves are of the Egyptian form and color, somewhat more hairy than usual in Egyptian cotton, but the hairs are short, as in some variations of the Egyptian type. The pulvinus and veins are green or tinged with dull reddish, as in Egyptian cotton. The pulvinus is very hairy and not enlarged, but the outer pairs of veins show an occasional tendency to unite at the base. There are 1 to 3 leaf nectaries, those of the midribs being sagittate.

The stipules of the main stalk and vegetative branches are long and slender as in rank-growing Egyptian cotton, while those of the fruiting branches are unequal, one narrow and the other broad, the latter often with two teeth.

The bracts are usually connate at their base for one-eighth to one-fourth inch, as often occurs in Egyptian cotton. The calyx has very distinct, broadly rounded lobes (Pl. V, *C*), more prominent than is usual in the Egyptian cotton but nearly equaled under some conditions, as in the Egyptian cotton grown near Los Angeles in the season of 1909.

The plants at Gizeh were quite woody and about 10 feet high, and had no tendency to produce elongated fruiting branches. Only one flower was borne on each fruiting branch. The pedicels of the flowers were very short and subtended by a small leaf, usually with one stipule very much enlarged and often toothed, somewhat like an involucral bract.

One of the most striking peculiarities in which the Niam-Niam cotton agrees with the Egyptian is the tendency to enlargement of one of the stipules of the leaves of the fruiting branches. It has been noticed in Arizona that abnormally large strong-growing plants of Egyptian cotton often have this tendency very pronounced, a fact suggestive of the possibility that such plants may represent reversions toward an ancestral form similar to the Niam-Niam cotton. The unequal development of the stipules has been considered in relation to Hindi hybrids, but such a tendency does not seem to be as pronounced in the Hindi hybrids as in the Egyptian cotton and in this African relative. Enlarged stipules are especially likely to be found in Egyptian cotton on leaves of short branches produced from the fruiting branches and may be connected with the tendency of such branches to produce organs intermediate between the ordinary leaves and the involucral bracts.

While the Niam-Niam cotton must certainly be considered in the study of the relationships of the Egyptian cotton, it seems more likely to prove a collateral relative than a direct ancestor. It is very difficult to believe that the Egyptian cotton descended from a kidney-seeded ancestor or from one that had the fruiting branches so shortened and specialized as the Niam-Niam cotton.

The most significant thing regarding these cottons from Mesopotamia and central Africa is that they may add something to the evidence of the existence of genuine Old World varieties of the Upland type of cottons. The Upland variety from Cochin China recently brought forward by Mr. Fletcher as an ancestor for our American Upland cottons is also very interesting from this standpoint.[a]

As seen growing at Gizeh the Cochin China cotton shows a remarkable resemblance to some of the Central American varieties and especially to two types from the Central Plateau and the Pacific slope of Guatemala, those that have been described as Pachon and Rabinal. The Guatemalan Upland cottons and other related types from southern Mexico show very close agreements with the Hindi cotton in so many of the characters that a rather close relationship must be supposed to exist. This renders the close resemblance of the Cochin China cotton to the Central American varieties all the more interesting.

The Cochin China cotton shows in Egypt the same bushy habit of growth with many upright vegetative branches as the Central Ameri can Upland cottons when first brought to the United States, though not carried to quite the same extent under the less extreme Egyptian conditions. The stems, leaves, and involucres are densely hairy as in the Central American cottons. The bracts also have the margins hairy and very firmly appressed in the same way as in the Central American cottons and perhaps to an even greater extent.

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[a] Fletcher, F. The Origin of Egyptian Cotton, Cairo Scientific Journal, vol. 2, no. 26, November, 1908.

The lobes of the calyx have the same tendency to grow into long teeth (Pl. V, A), and the bolls have the same conic-oval, abruptly apiculate form which several of the Central American varieties share with the Hindi cotton. In short, the resemblance seems so complete that if the Cochin China cotton had been found in Central America it would have been considered as only one more of the relatively slight local variations shown by the general type represented by the Rabinal and Pachon varieties. The most notable difference was an apparent absence of bractlets, but this condition could probably be found on second-year wood in the Central American varieties. While the Cochin China cotton, like the Central American varieties, appears to be a relative of our American Upland cottons, there are native Mexican varieties that seem to be still more closely related to some of our United States Upland varieties. Yet it is not impossible that Mr. Fletcher's idea of tracing the Cochin China cotton to the United States through an early introduction of so-called "Siam cotton" may turn out to be true of our long-staple Upland type still grown in Louisiana.

If the Cochin China cotton were more nearly identical with our United States Upland cottons it might be looked upon as an introduction from the United States, but it is much less likely that a local Central American variety has been carried to Cochin China. The information of Mr. Fletcher's correspondent, that this cotton was really indigenous in Cochin China, may therefore be credited.[a]

While the existence of these additional relatives of the Egyptian and Hindi types of cotton in the Old World does not affect the evidences of relationship that have been pointed out between these types of cotton and others that appear to be natives of America, it does have a bearing upon the question of how these members of American types of cotton reached the Old World. If many sorts like the Hindi, Egyptian, Niam-Niam, and Cochin China cottons are found in different parts of the Old World it will not be reasonable to believe that they represent recent importations from America, since the time of Columbus. It will be necessary to consider the possibility that American types of cotton, like the coconut palm, sweet potato, and other economic plants of American origin, were carried across the Pacific Ocean in prehistoric times.[a]

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[a] Fletcher, F. The Botany and Origin of American Upland Cotton. Cairo Scientific Journal, vol. 3, no. 38, November, 1907, p. 263.

If our long-staple varieties of Upland cotton originated in the East Indies it is reasonable to expect that other superior types of Upland cotton may be found in that part of the world. Indeed, Mr. Fletcher's Cochin China cotton seems to be a promising type, worthy of attention from the standpoint of acclimatization. The bolls are larger than in our long-staple Upland varieties and the lint is of good length. The very large and well-closed hairy involucral bracts would have value from the standpoint of weevil resistance, like the similar bracts of the Central American varieties which exclude the boll weevils from the young buds, as already noted in describing the hybrids of the Cochin China cotton.[b]

SUPPOSED INCREASE OF HINDI COTTON.

The popular belief in Egypt is that the proportion of Hindi cotton is increasing, though there seems to be no way to obtain definite information on this point. Intelligent natives declare that they remember when the Mit Afifi or the Jannovitch varieties produced fields of uniform plants, all of the same height, with none of the irregularities now shown by the tall hybrid plants of the Hindi-infested fields. But in the absence of any actual countings in former years it is not possible to determine what change has taken place.

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[a] Food Plants of Ancient America, Smithsonian Report 1903, pp. 481–497.

Agricultural History and Utility of the Cultivated Aroids, Bulletin 164, pt. 2, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910.

History of the Coconut Palm in America, Contributions from the United States National Herbarium, vol. 14, pt. 2, 1910.

[b] The successful cultivation of a so-called "Cambodia" cotton in British India has been noticed in a recent Consular Report, issued while this bulletin was in preparation. The facts are of special interest in view of the many unsuccessful experiments that have been made in India with Upland varieties from the United States. The statement is as follows:

"In Tinnevelly district, Madras Presidency, at the extreme southern end of the peninsula, there had been planted up to October about 17,000 acres in what is known as Cambodia cotton. This is a variety of acclimatized American cotton, introduced into the country about four years ago, which is being quite successfully grown and which yields far more fiber per acre than any of the old varieties.

"Last year a total of 15,000 bales of Cambodia was produced on 15,000 acres of the black soil of Tinnevelly, and this season, in addition to the larger area already reported as planted in that district, the agricultural department is experimenting with it in several other parts of the Presidency with a view to its general adoption by growers. It is said to thrive on irrigated lands, and should it prove even partially as successful in other districts as in Tinnevelly, there is little doubt that within a very few years it will be grown throughout the whole of south India, if not elsewhere in the country.

"As the fiber of the Cambodia compares favorably with that of American Upland cottons, it is not too much to say that India may within a few years become a serious competitor of the United States in meeting the world's demand for the commodity, instead of furnishing only the inferior grades as at present." (*Report of Nathaniel B. Stewart, consul at Madras, India, in Daily Consular and Trade Reports, December 17, 1910.*)

From the standpoint of the Mendelian theory of heredity an increased representation of the Hindi characters would not be expected to occur unless additional contamination took place from outside sources, which appear to be lacking in Egypt. Mathematicians have shown that characters expressed according to the Mendelian theory would not tend to increase, but would remain at the same general proportion in a mixed population.[a]

Nevertheless, an increasing dominance or stronger tendency of expression of the Hindi characters should not be dismissed as impossible, for it has been noticed in experiments with Egyptian-Upland hybrids that the Upland characters seem to attain a more and more predominant expression in the later generations, even when selections are made with a view to preserve the Egyptian or intermediate characters among the hybrids. Though no direct statistical evidence regarding the supposed increase is likely to be obtained, it may be possible to throw light on the question indirectly by the study of the tendencies of expression shown in artificial hybrids between the Egyptian and Hindi types. Experiments of this kind were begun by the making of such hybrids in Arizona in the season of 1909.

The popular impression of a gradual increase in the proportion of Hindi cotton is supported by the general opinion of the commercial world that the quality of the Egyptian cotton is declining. This may mean that poorer qualities are being sent out under the same marks or that the ginning establishments are finding it more difficult to keep their product up to recognized standards. Either of these results, or both, might naturally be caused if the Hindi cotton continues to multiply in the face of the selection that is now being applied.[b]

Considered on a percentage basis, a considerable amount of selection has undoubtedly been directed against the Hindi cotton. In the Delta region a large proportion, probably 50 per cent or more, of the Hindi plants that germinate in the fields are rogued out. The sorting of the fiber in the ginhouses must take out a still larger percentage of the Hindi cotton that is harvested.

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[a] Hardy, G. H. Mendelian Proportions in a Mixed Population. Science, n. s., vol. 28, p. 48, July 10, 1908.

[b] The idea of a progressive deterioration of the Egyptian product is confirmed by a recent authoritative statement published while the present report was in preparation: "There is no gainsaying the unanimous evidence that the general character of Brown Egyptian cotton [by which Lancashire means Afifi] has gone down most markedly from the standard of 15 years ago. All the spinners of fine counts, to whom strength is everything, speak with regret of the Afifi of those days. Without exception they say that during recent years they have continually been compelled, in order to maintain their standards of strength,

Some of the ginners are also said to sift out the smooth seeds, or even to resort to hand picking to keep the smooth Hindi seeds from being planted. While it is to be expected that the various ginning establishments would be found to differ greatly in the thoroughness with which these precautions are observed, the general effect must be to exclude a large proportion of the Hindi seed every year. Under any Mendelian rule or other customary idea regarding the effects of selection it might be expected that the expression of the Hindi characters would have declined long since to a negligible quantity, but the facts certainly do not correspond to this expectation. The result demonstrates instead that the system of selection now in operation is entirely inadequate to eliminate the Hindi variations.

As already noted in connection with the seed characters of the Hindi cotton, the tendency to an increased representation of this type is not limited to the factor of prepotency, but may prove to be due partly or wholly to more prompt germination of the seeds, owing to the absence of fuzz that allows more effective contact with the soil. Experiments with other types of cotton have shown that varieties having less fuzz germinate more promptly, but comparisons will also be made between Egyptian and Hindi.

ESTIMATE OF DAMAGE FROM THE HINDI CONTAMINATION.

As the percentages of Hindi cotton in the Egyptian fields do not represent the full amount of Hindi contamination, so they do not indicate the full extent of damage to the crop. In addition to the true Hindi plants and the obviously Hindi-like hybrids, supposed to represent the first generation, more careful inspection always shows a considerable number of obscure or dilute hybrids as well as many individual variations that may reasonably be ascribed to the same general fact of Hindi contamination. These aberrant plants include those that show the white flowers, the flowers with pale spots, and other peculiarities that can often be detected only by

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to raise the mark or grade of cotton they use, and to add increasing proportions of superior varieties, such as Nubari and Jannovitch, merely to obtain the same results as they formerly secured with Afifi alone. Strength is absolutely essential in the manufacture of 'twist' yarns for warping, and in spite of improved spinning processes, greater loss in waste through taking out a larger proportion of short staple, and more careful and costly methods generally, the spinners have had the greatest difficulty in maintaining the quality of their yarns." (See Todd, John A., "The Market for Egyptian Cotton in 1909–1910," L'Egypte Contemporaine, no. 5, January, 1911, p. 5.)

careful comparison of all the parts, including the seeds and lint. A complete census of the aberrant plants of a field requires too much time to make it generally feasible. Moreover, the cotton in Egypt was not yet far enough advanced in July, 1910, to allow such a study to be completed. The visit was made at that season because the vegetative characters of Hindi plants were known to be more readily visible at that time.

Counts made in a field of Ashmuni cotton raised in Arizona in 1909 from imported seed gave over 40 per cent of the plants showing distinct departures from the normal characteristics of Egyptian cotton, mostly in the direction of the Hindi. A similar diversity would probably be found in some of the Egyptian fields representing the same variety of cotton. With the better varieties such as Mit Afifi and Jannovitch the percentage of dilute hybrids and variants, as of true Hindi and obvious hybrids, is doubtless considerably less though by no means a negligible quantity.

It would probably be well within the truth to estimate that the results obtained by counting would at least be doubled if they were to include the later generations of hybrids and dilute crosses that increase the diversity and diminish the value of the crop. If the average of the percentages shown in the different countings of Hindi plants be accepted as the basis of calculation, a total estimate of about 12 per cent would represent the extent of the Hindi contamination that would become visible under a more careful inspection of the Egyptian fields. Estimated even at 10 per cent, the annual damage of the Hindi cotton must run well above $10,000,000, perhaps even to twice that amount. It is true, of course, that any definite figures must be in the nature of guesswork; they can serve only in a general way to indicate the magnitude of the factor of diversity in the Egyptian cotton crop.

While the cotton of the Hindi and other variant plants is not altogether worthless, there can be no doubt that the crop as a whole would be far more profitable to the farmer if all these plants were destroyed, even though nothing took their places. A general diminution in yield is due to the infertility of many of the hybrids and other aberrant plants; a general depreciation of the value of the crop is due to the residuum of inferior cotton that the sorting does not remove, to the expense of the sorting, and to the relative waste of labor in growing and picking the low-grade cotton. These elements of loss recur with every season and represent a large tax upon the industry. They also represent roughly the advantage that American farmers may hope to gain by paying more effective attention to the factor of selection as a means of maintaining the purity and productive efficiency of varieties.

OTHER CAUSES OF DETERIORATION OF THE EGYPTIAN CROP.

While an increase of the proportion of Hindi cotton would explain a reduction in the yield as well as in the quality of the crop, it is probable that other causes are responsible for a share in the decline. Indeed, some writers on the subject, overlooking the Hindi factor, have used considerable ingenuity in imagining other causes of deterioration and are calling for radical measures of reform to check, if possible, the downward tendencies. Statistics indicate a general decline in production at the rate of about 100 pounds of lint per acre during a period of about 12 years. Such a reduction is a very serious matter from the standpoint of the native cultivator who operates on a very small piece of land at a very high rental. Even when the tenant has to pump his own irrigation water his rent may run at the rate of $40 or $50 per acre. Under favorable conditions a return of $100 may be secured, but the margin is often very narrow, only $5 to $10 for a season's work.

In spite of the decline in yield, the increase of the area of production by new irrigation works may maintain or even increase the total output of the country as a whole, though it is evident both in Lower and Upper Egypt that the extension of cotton into newly reclaimed areas is likely to be a very gradual process attended by considerable difficulties. Other possibilities of extensive cotton production are said to exist in the Egyptian Sudan, where many efforts for agricultural progress, including large projects in irrigation, are now being made.

One of the favorite theories to account for the lessening yields of cotton is that the varieties have run out. This theory may be true in the sense already discussed, that of deterioration due to hybridism and resulting diversity, but it is probably not true in the sense that is commonly supposed, that the varieties have weakened and declined in vigor and fertility. With plants long propagated from cuttings, such as strawberries and potatoes, it is believed that old varieties become weaker and less resistant to disease after a period of a few decades, but with open-fertilized, seed-propagated plants like the cotton, the idea of varieties running out is not considered as having received any adequate demonstration. Some of the native cultivators declare that all the plants used to grow as large on their land as the tall hybrids do now and that they were fertile in proportion to their size, but such a difference might be due to a decline in the fertility of the soil as well as to a deterioration of the variety.

The tradition of perpetual fertility of the Egyptian soil, annually renewed by the sediment deposited by the flood of the Nile, does not apply to the cotton lands, for this crop is raised on an entirely different system having no relation to the agriculture of ancient Egypt. Ancient Egypt depended on winter and spring crops that could be grown during the intervals between the summer inundations, but cotton requires the whole warm season, spring, summer, and autumn. It has to be irrigated in the spring before the floods come and is harvested during the flood period. Cotton can be grown, therefore, only on land that is protected from the floods and provided with canals for perennial irrigation. The only Nile mud that comes to these lands is a very little in the turbid water of the later irrigations that are given to the cotton after the river rises. There is no deposit of mud from large volumes of water turned into basins and allowed to settle as under the old system of irrigation at flood time. Hence there is every reason to expect a gradual decline in the fertility of the cotton lands, a decline likely to be noticed first in the lighter and poorer soils but also likely to affect the others in time. Whether this decline has already become a serious factor in reducing yield might require a very careful investigation to determine, but it is very likely to be a contributing factor.

The use of fertilizers is already recognized as a serious question in relation to the cotton industry. As in the United States, natural and artificial manures are used with pronounced benefit on the poorer and lighter lands while the heavier soils show little or no response. The domestic supply of fertilizing material is greatly reduced by the natives in their universal use of the dung of domestic animals as fuel. Some writers have seen an evidence of agricultural efficiency in the making of such material up into cakes and hoarding it around the native houses, but the object is to cook the family meals, not to fertilize the land.[a]

A theory receiving much attention at present is that the decline of the cotton crop is due to a rise of the water table or level of the subsoil water in the soil, resulting from infiltration from canals and the use of larger quantities of water for irrigation purposes. While it is evidently true in Egypt, as in the United States, that too much water is bad for cotton, it hardly seems probable that the change of the water table has been sufficiently serious and general to be responsible for any very large part of the decline of the crop. The recent improvements of irrigation facilities are making it easy for the cultivators to injure their crops by using too much water, a tendency that seems to be very general in irrigated regions. Indications of such injury could often be seen in the fields. In some cases continued excess of water had evidently interfered with growth, so that the cotton of the water-logged fields remained very small. In other cases excess of water appeared to be responsible for too vigorous growth and late fruiting, with the probable result of a smaller crop. American cotton planters are familiar with the fact that too much rain often cuts down the crop by inducing additional growth near the beginning of the fruiting period. A whole crop of buds or young bolls may be shed that would have grown to maturity if the weather had continued dry.

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[a] Foaden, G. P. Notes on Egyptian Agriculture. Bulletin 62, Bureau of Plant Industry, U. S. Dept. of Agriculture, pp. 26-33.

Cotton growing on lands along permanent watercourses, in the Zagazig district, where the water table must have been kept within a few feet of the surface, did not show any serious impairment except for a few rows along ditches or ponds that supplied water practically on the surface. The small size and pale color of one or two rows along the dikes often indicated serious injury by the close proximity to water, but usually there was a rapid improvement farther back. A recent publication gives the results of many investigations of water level in wells and concludes that the modern system of irrigation has had no serious general effect in raising the level of the subsoil water. On the other hand, it is pointed out that a secondary artificial water table may be formed when superfluous irrigation water collects over an impervious subsoil layer.[a]

Disease also may play a part in the decline of production. As pointed out by Mr. Fletcher, in the vicinity of Gizeh some of the fields of cotton show irregular patches of very inferior plants, with some dead and dying. On examination of the roots Mr. Fletcher found the fibro-vascular bundles stuffed with fungous mycelium as in the wilt disease of cotton in the United States. Samples of roots of cotton plants affected in the same way were also sent by Mr. Fletcher some years ago to Mr. W. A. Orton, of the Bureau of Plant Industry, but no definite identification of the disease could be made.

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[a] Ferrar, H. T. On the Creation of an Artificial Water Table in Egypt, Cairo Scientific Journal, vol. 4, p. 153, July, 1910.

The conclusions of this paper are stated as follows:

"It is reasonable to suppose that a small quantity of water has been retained by the alluvium each succeeding year, for it is not likely that a great augmentation of subsoil water would take place in a year or two, and in the absence of substantiated evidence we must assume that by degrees water has been accumulating in the soil since the introduction of perennial irrigation. Observations made in the provinces of Menufia and Gharbia have shown that at the present time (May 1) a layer of saturation may be found which is seldom more than two meters below the soil surface. The upper surface of this artificially saturated layer has been called the *artificial water table.*

"Some misapprehension exists with regard to the water which is found in the Nile alluvium and it will be of interest, therefore, to state tentatively two main conclusions drawn from observations made at more than 150 experimental tube wells which have been under observation during the past year. The observations made at these wells in Lower Egypt all support the view that there are two water tables:

"1. *A natural water table which is independent of the works of man, except locally where extra permeability allows a constant supply of irrigation water to be added.*

"2. *An artificial water table which was created by the act of the introduction of perennial irrigation by Mohammed Aly Pasha.* It is thought that *this artificial water table has gradually become higher, owing mainly to excessive watering of crops,* until at the present day it has a deleterious effect upon the fertility of the soil."

It has been supposed that the Egyptian cotton is resistant to the wilt disease, but that this resistance is not absolute seemed to be shown very clearly in one of Mr. Fletcher's experiments already noted. In a type of cotton practically resistant to such a disease a large amount of unrecognized damage might be done. Mr. Orton states that in the United States the wilt disease is responsible for much damage outside of the most seriously infested areas where the plants are killed.

PROSPECTS OF EGYPTIAN COTTON IN THE UNITED STATES.

Though it is to be expected that the Hindi contamination and other causes of decline of the cotton crop in Egypt will eventually be recognized and removed, there is no reason to expect any sudden or complete change in the present conditions. The yield and quality may be expected to fluctuate somewhat with the seasons, but such differences are likely to be less serious in Egypt than in almost any other country.

The Hindi cotton might be eliminated eventually if a better system of selection were applied or new and uniform strains could be developed and substituted for the present diverse stocks. More extensive fertilizing might counteract the diminishing fertility of the soil. Drainage works are being extended and improved methods of controlling insect pests are being applied. More hardy varieties may also be developed, analogous to the wilt-resistant varieties of Upland cotton bred by Mr. Orton in the United States.

But all of these measures are likely to require considerable periods of time, quite as long, indeed, as would be needed for the elimination of the Hindi, and this will give our newly established cotton-growing communities of the Southwest a fair opportunity to market their first crops, if they decide to undertake the production of Egyptian cotton on a commercial scale, instead of the short-staple Upland cotton they are now planting. One of the difficulties in establishing such an industry is that it needs to begin on a sufficiently large scale to provide the necessary ginning and baling facilities. Manufacturers are not willing to buy small quantities of cotton from a new region.

No assurance can be given, of course, that the present high prices of Egyptian cotton will be maintained for even a few years. The farmer will have to judge for himself whether the normal relations of supply and demand are likely to continue and to have their normal influence on the prices. The present status of the Egyptian industry is only one factor of the problem, but the prospects in this quarter seem to favor the proposed establishment of an Egyptian cotton industry in the Southwest.

It need not be supposed that the culture of Egyptian cotton in the United States will involve an injurious competition with the Egyptian industry. The irrigated districts of Arizona and southern California where the experiments with the Egyptian cotton have been carried on are not very extensive, nor thickly populated. Settlement is going on in a very gradual way, as irrigation facilities are provided. Moreover, the opening of an additional source of supply of Egyptian cotton would be likely to improve the commercial prospects of this type of fiber. The danger is already recognized in Egypt that if prices remain too high markets may be lost by the further substitution of inferior kinds of cotton in fabrics for which Egyptian has been used.

Recently published results of an investigation of this question show that an extensive substitution of other types of cotton for the Egyptian has already taken place and that there has been a serious decline in some lines of Egyptian cotton goods as a result of improvements in the weaving machinery and finishing processes that make it possible to use cheaper materials not previously employed for such purposes. The plan of substitution seems to have succeeded beyond all expectations, as the following statements will show:

> It is in these lower grade goods that the substitution of American for Egyptian yarns has shown the most marked development. The substitution has taken place in various ways, but all due to the one cause—the great difference in price between American and Egyptian yarns. The high price of Egyptian cotton has compelled the spinners to devote their attention to producing a finer spun yarn from American staple than was formerly thought possible. Until a few years ago 40's were regarded as practically the limit of American spinning. Now by improved processes and the adoption of finer methods of spinning (e. g., combing, which was formerly confined to Egyptian yarns) 60's, 70's, and 80's of satisfactory quality can be spun from American. Though perhaps not equal in strength to the Egyptian yarns of the same count, these yarns have proved an excellent substitute in many branches of the trade. * * *
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> The secondary difficulty of overcoming the dealers' prejudices against American cotton was of short duration. Most of the goods in question were well-established stock lines which the dealers had sold for some years at fixed prices, and to raise these prices was impossible. But the rise in price of the Egyptian yarns was too great to be covered by any possible sacrifice of profits on the part of the manufacturers or the dealers, and there was no alternative but to abandon the Egyptian yarns. Had such a suggestion been made a few years ago, it would have been ridiculed; but the shopkeepers, more than half persuaded by the obvious excellence of the goods, were compelled to try them, and their success was immediate and astonishing. Customers showed no

hesitation in choosing between the old goods at enhanced prices and the new cheaper goods, and the success of the latter in use rapidly disposed of any fears of their practicability. The customers either did not know the difference or were quite pleased with the substitute. * * * The result is that the trade in those fabrics, where the substitution of cheaper cotton was impossible, has dwindled to very small proportions. The consumers declined to pay the high prices, preferring goods of cheaper quality at something like the old prices. And the manufacturers have not been slow to meet the requirements of the market. Much of the cotton trade is season's goods, and even the established stock lines may suffer a serious loss of demand in one season through the appearance of new goods in competition. The manufacturers have therefore placed before their customers alongside of the old goods at increased prices entirely new and cheaper goods of different materials and new designs which have proved eminently successful. Thus in the end substitution though impossible directly has won its way indirectly to the same result; the old fabrics made from the expensive Egyptian cotton have been largely replaced by new fabrics of cheaper materials mostly American.[a]

It would be a mistake to suppose that the problem of uniformity can be completely solved by breeding and selection, however carefully and efficiently done. The quality of the fiber depends on favorable conditions of growth that often vary in the same field. Even the same individual plant may produce entirely different grades of fiber as a result of changed conditions during the same season. Any sudden forcing or checking of growth is likely to injure both the yield and the quality of the cotton crop. A large amount of experimenting may still be necessary to determine the best methods of culture and irrigation to secure the largest yields and the best quality of lint.

The cultural problems are not the same as with crop plants where the chief object is to promote vigorous growth and a large bulk of plant tissues. With cotton both the yield and the quality are likely to be cut down if the plants are too large and luxuriant. The tendency to overgrowth is a serious difficulty with the Egyptian cotton on some of the very rich new soils in the Southwestern States. How to hold this undesirable luxuriance in check is one of the chief problems. Earlier crops, larger yields, better fiber, and easier picking can all be obtained if the excessive growth of the plants can be restricted. Nor can the new cotton-growing districts be expected to prosper on the basis of a single crop, however profitable it may appear to be at first. To grow cotton continuously on the same soil in an irrigated region is likely to invite disease. Rotations of crops and other forms of diversified agriculture will be needed to insure permanent prosperity.

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[a] See Todd, John A., "The Market for Egyptian Cotton in 1909–1910," L'Egypte Contemporaine, no. 5, January, 1911, pp. 3, 4, and 6.

CONCLUSIONS.

The standards of uniformity are higher with the Egyptian cotton than with American short staples, because the Egyptian cotton is used for superior fabrics and for other industrial purposes where strength is required. The prospects of establishing a successful Egyptian cotton industry in America depend on the possibility of producing a uniform crop and avoiding the need of a subsequent sorting of the fiber.

In the Egyptian industry the requirement of uniformity is met, in part, by a system of careful grading and sorting, made possible by cheap labor not available in the United States. Inspection of the fields in Egypt during the early part of the growing season shows a large and very general contamination with the inferior type of cotton known as Hindi that produces only a short, sparse, white lint, quite unlike that of the true Egyptian cotton.

The claim that the Hindi cotton is all removed from the field at the time of thinning the plants is not warranted by the facts, for the Hindi type and obvious hybrid forms are to be found in nearly all the fields, often in considerable proportions, sometimes more than 10 per cent of the total number of plants. Removal of the Hindi plants is practiced only at the period of thinning and very seldom results in any complete elimination of the Hindi cotton from the fields.

The injury caused by the Hindi contaminations is not limited to the proportion of Hindi plants and obvious hybrids that were counted in the fields. Many plants not readily distinguished as Hindi hybrids at earlier stages of growth, give later indications of hybrid nature in white flowers, pale-green bolls, or sparse, inferior lint, or in relative or complete sterility. The Egyptian system of roguing the plants only at the time of thinning would not effect a complete elimination of the Hindi cotton, even if it were generally applied.

An increase of the Hindi contamination is popularly supposed to have taken place in Egypt, in spite of the selection that has been directed against it. Such an increase would be able to cause a serious decline in the yield as well as in the quality of the Egyptian crop, quite independent of other possible causes of deterioration that are supposed to explain the lessened production of the Egyptian fields, such as diminished fertility of the soil, rise of the water level in the soil, plant diseases, and insect pests.

The supposed increase in the proportion of Hindi cotton may prove to be due to the naked seeds that permit a more rapid absorption of water and a more prompt germination than fuzzy seeds. Prompt germination would allow the Hindi seedling plants to make more rapid growth in the earlier stages and thus gain an advantage over Egyptian seedlings in the same hill. It is also possible that the

Hindi characters are prepotent over the Egyptian, like the Upland characters in the later generations of Egyptian-Upland hybrids.

Breeding experiments have shown that it is possible to secure a much higher degree of uniformity in Arizona than now exists in most of the cotton fields in Egypt. Attention to the external characters enables the Hindi cotton and other undesirable variations to be removed from the fields before the flowers open and hence before cross-fertilization becomes possible. If reasonable care be used in maintaining the uniformity of these types, it does not appear that the American-grown Egyptian cotton is likely to suffer any commercial disadvantage on the ground of lack of uniformity in comparison with the Egyptian crop, even though we do not go to the expense of establishing large ginning establishments where the cotton is laboriously sorted by hand.

The greater popularity of the brown-linted varieties of Egyptian cotton may be explained by the advantage that the color gives in sorting out the inferior white Hindi fiber. The exclusion of the Hindi cotton by a more efficient system of selection will enable white varieties to be grown in Arizona and thus produce longer and stronger fiber than brown varieties are likely to afford. A study of many variations and hybrids of the Egyptian cotton shows a distinct tendency for the brown color to be associated with short fibers.

It is possible that the reversions to the Hindi characters may continue to appear in small numbers, even in carefully selected stocks, as in analogous naked-seeded variations occasionally found in uniform carefully selected varieties of Upland cotton. Nevertheless, experiments indicate that such reversions to the Hindi characters are not likely to interfere with the development and preservation of uniform strains of Egyptian cotton in the United States if the proper methods of selection are applied.

PLATES.

DESCRIPTION OF PLATES.

Plate I. Fig. 1.—Cotton field at Benha, Egypt, showing size and habits of growth of Egyptian cotton plants at the middle of June. Fig. 2.—Closer view of an Egyptian cotton plant with a Hindi plant on either side.

Plate II. Fig. 1.—View from the outside of the cotton field shown in Plate I. Fig. 2.—General view of a larger field, showing differences in the conditions of the plants at the middle of July.

Plate III. Bracts and calyxes of Hindi cotton: *A*, From a plant grown at Gizeh, Egypt, by Mr. F. Fletcher from seed obtained in Mesopotamia; *B*, *C*, from two flowers of Hindi cotton from Fayum, Egypt. (Natural size.)

Plate IV. Bracts and calyxes of cotton from Calioub, Egypt: *A*, Egyptian; *B*, Hindi hybrid. Note the longer laciniæ on the Hindi hybrid bracts; also, that the calyx teeth are intermediate between the Egyptian (Pl. IV, *A*) and the Hindi (Pl. III, *A*, *B*, *C*). The teeth on one side of the Hindi hybrid calyx are rolled back in the photograph. (Natural size.)

Plate V. Bracts and calyxes of cotton grown at Gizeh, Egypt: *A*, *B*, Of two flowers of Hindi-like Upland cotton from Cochin China, grown by Mr. F. Fletcher; *C*, of a relative of the Egyptian cotton from the Niam-Niam country of central Africa, grown by Mr. W. Lawrence Balls.

Plate VI. Bolls of Egyptian and of Hindi cotton grown at Somerton, Ariz., in the season of 1909, showing differences in the shape and the markings of the surfaces: *A*, Egyptian; *B*, Hindi. The tooth calyx of the Hindi cotton can be contrasted with the truncate saucer-like calyx of the Egyptian. (Natural size.)

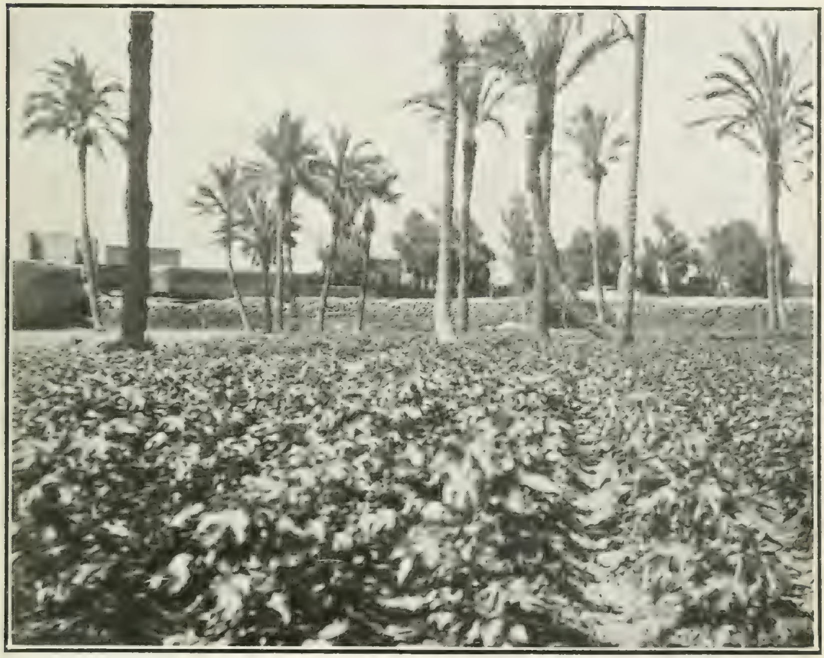


FIG. 1.—A FIELD OF EGYPTIAN COTTON INTERMIXED WITH HINDI.

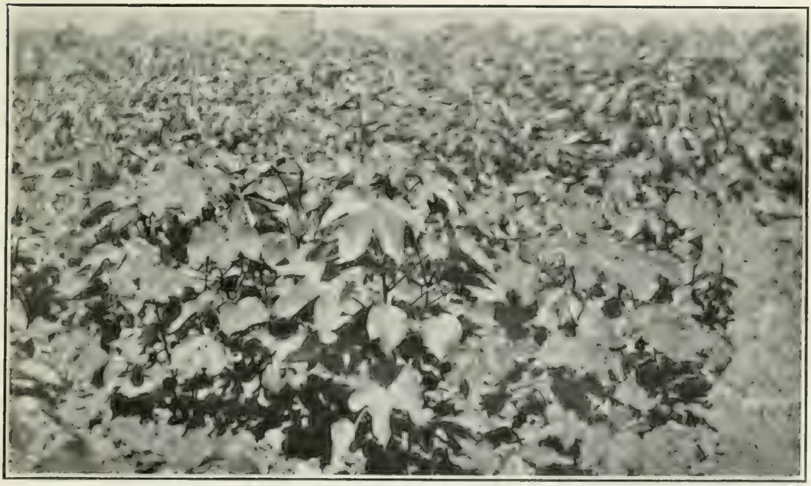


FIG. 2.—AN EGYPTIAN COTTON PLANT BETWEEN TWO HINDI PLANTS.

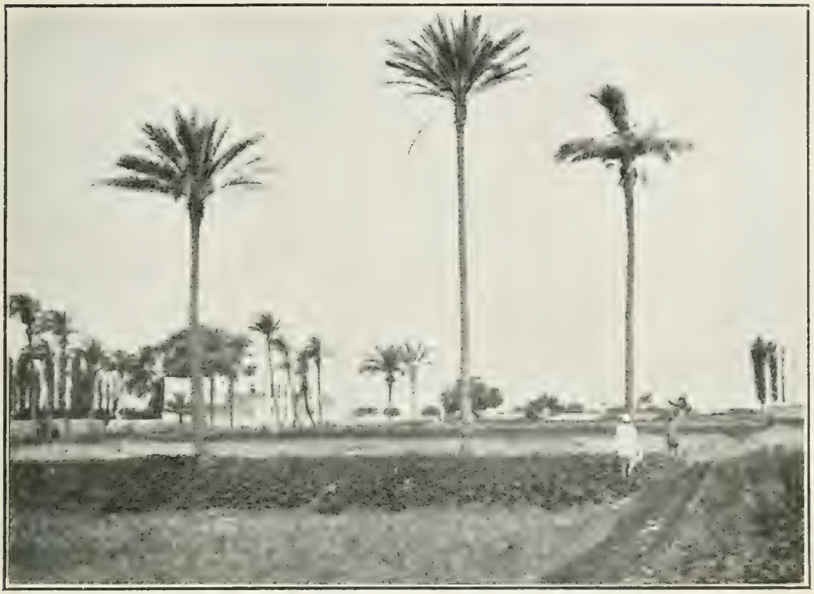


FIG. 1.—SMALL COTTON FIELD AT BENHA, EGYPT.

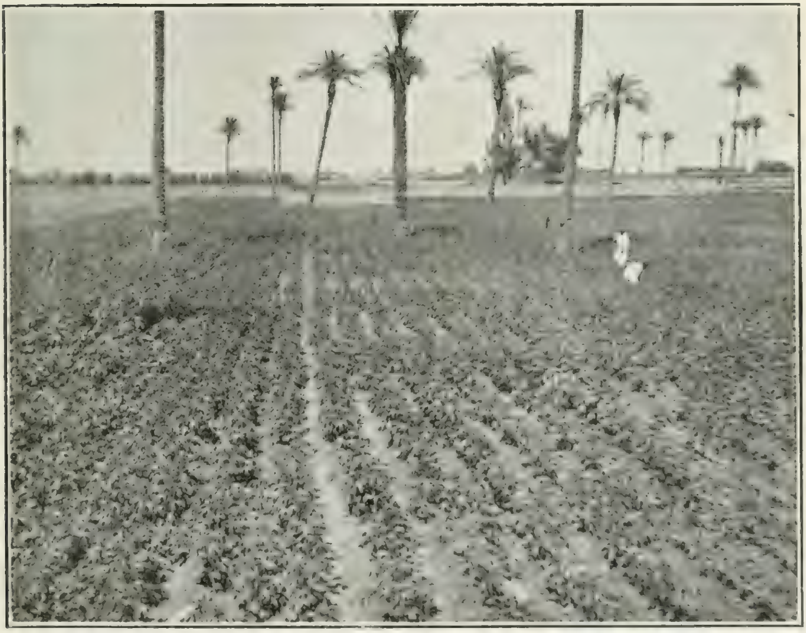
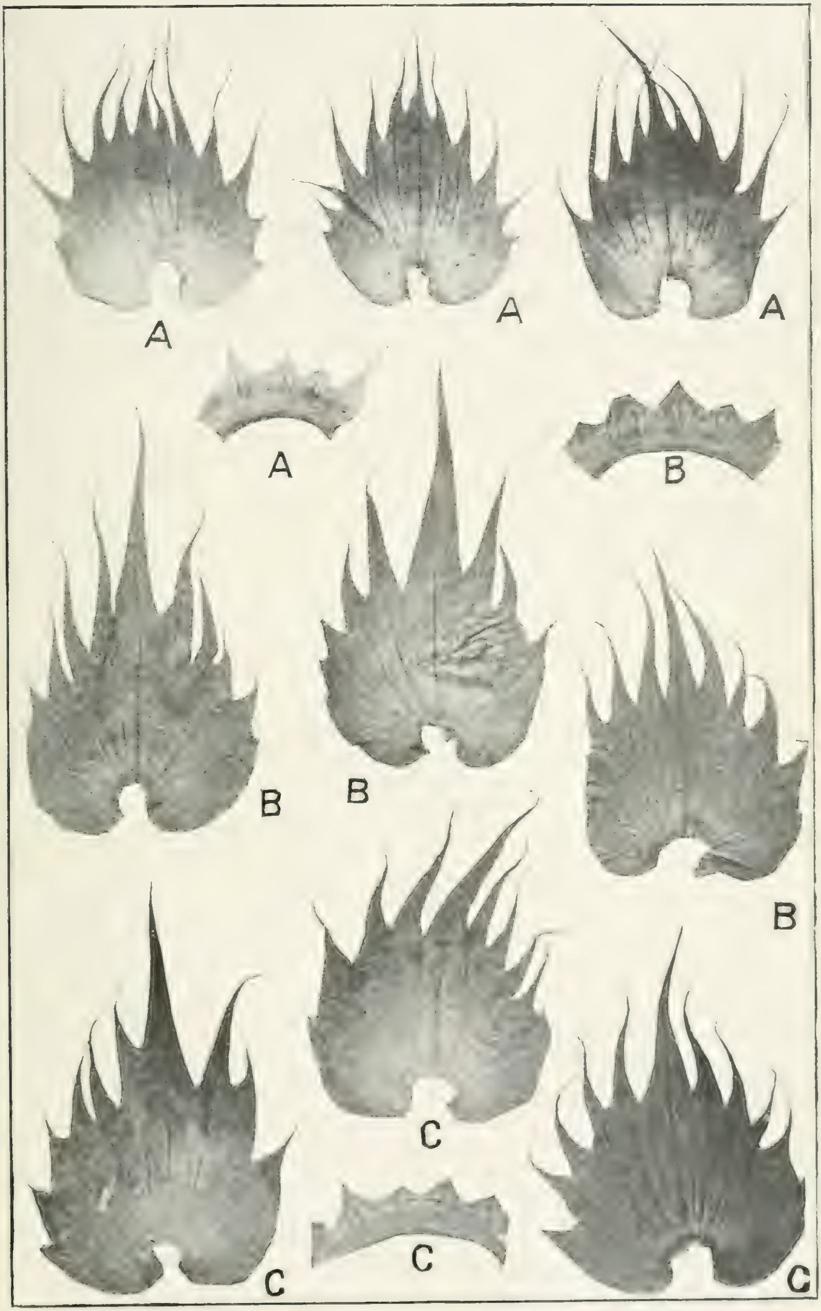
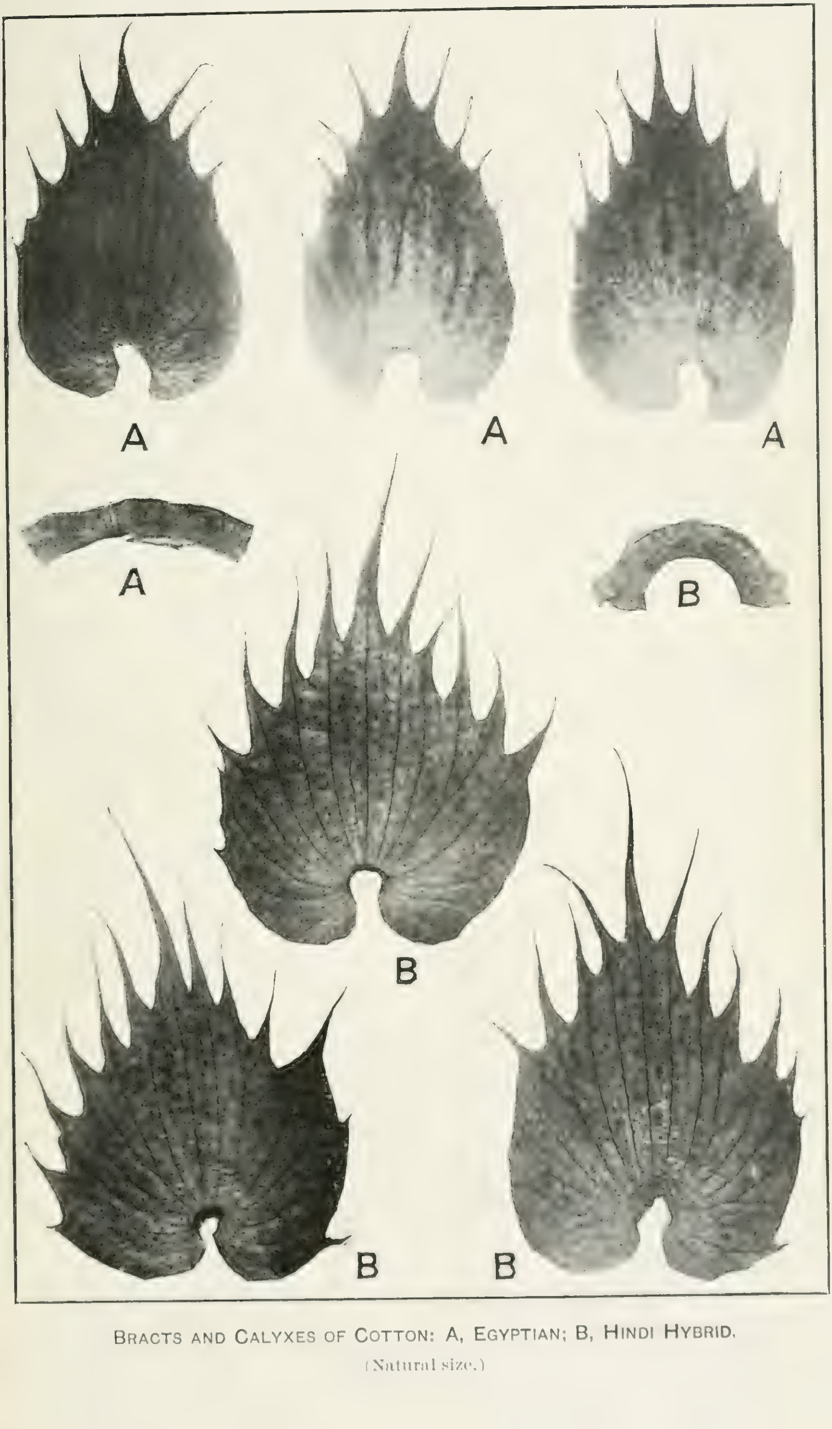


FIG. 2.—LARGE COTTON FIELD AT BENHA, EGYPT, WITH NATIVES IRRIGATING.



BRACTS AND CALYXES OF HINDI COTTON: A, FROM MESOPOTAMIA; B AND C, FROM FAYUM, EGYPT.

(Natural size.)



BRACTS AND CALYXES OF COTTON: A, EGYPTIAN; B, HINDI HYBRID.

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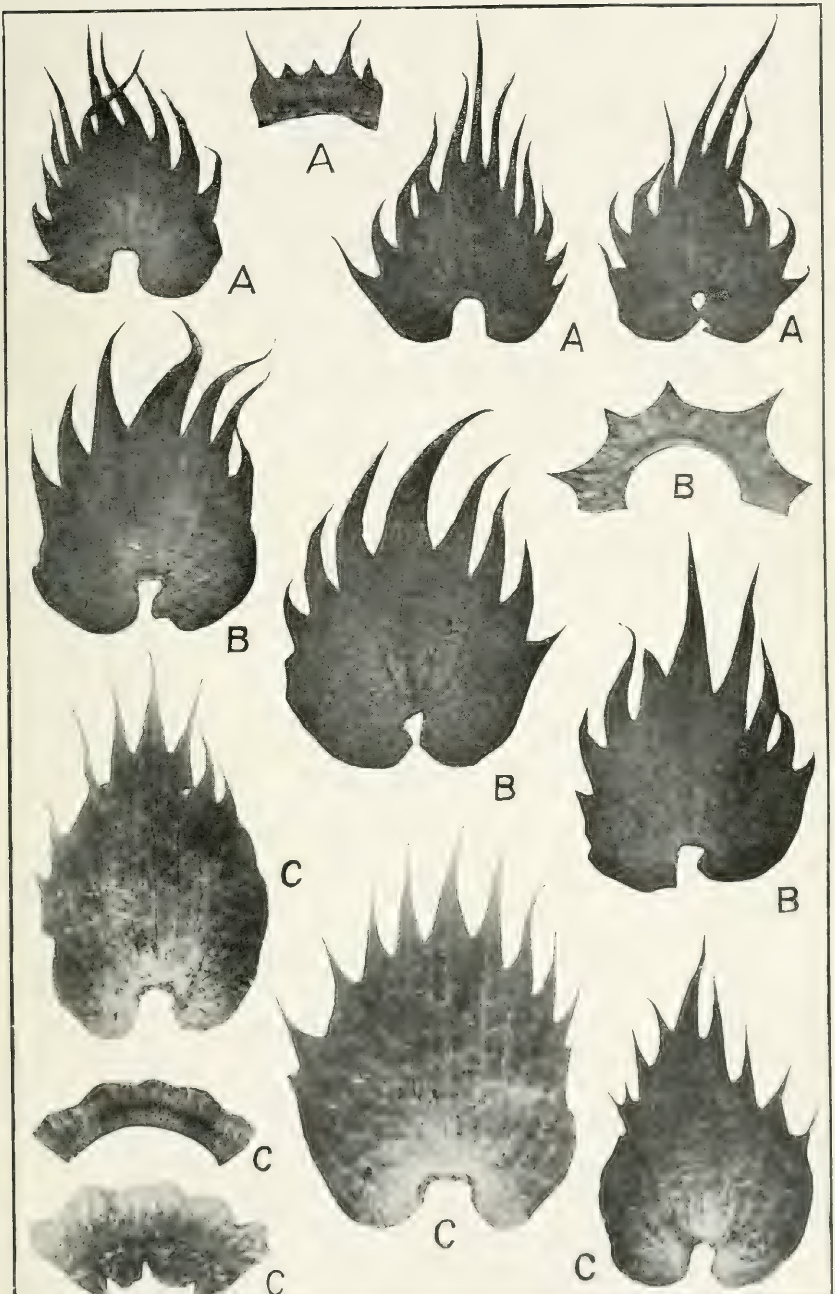

BRACTS AND CALYXES OF COTTON: A AND B, HINDI-LIKE UPLAND FROM COCHIN CHINA; C, A RELATIVE OF THE EGYPTIAN FROM CENTRAL AFRICA.

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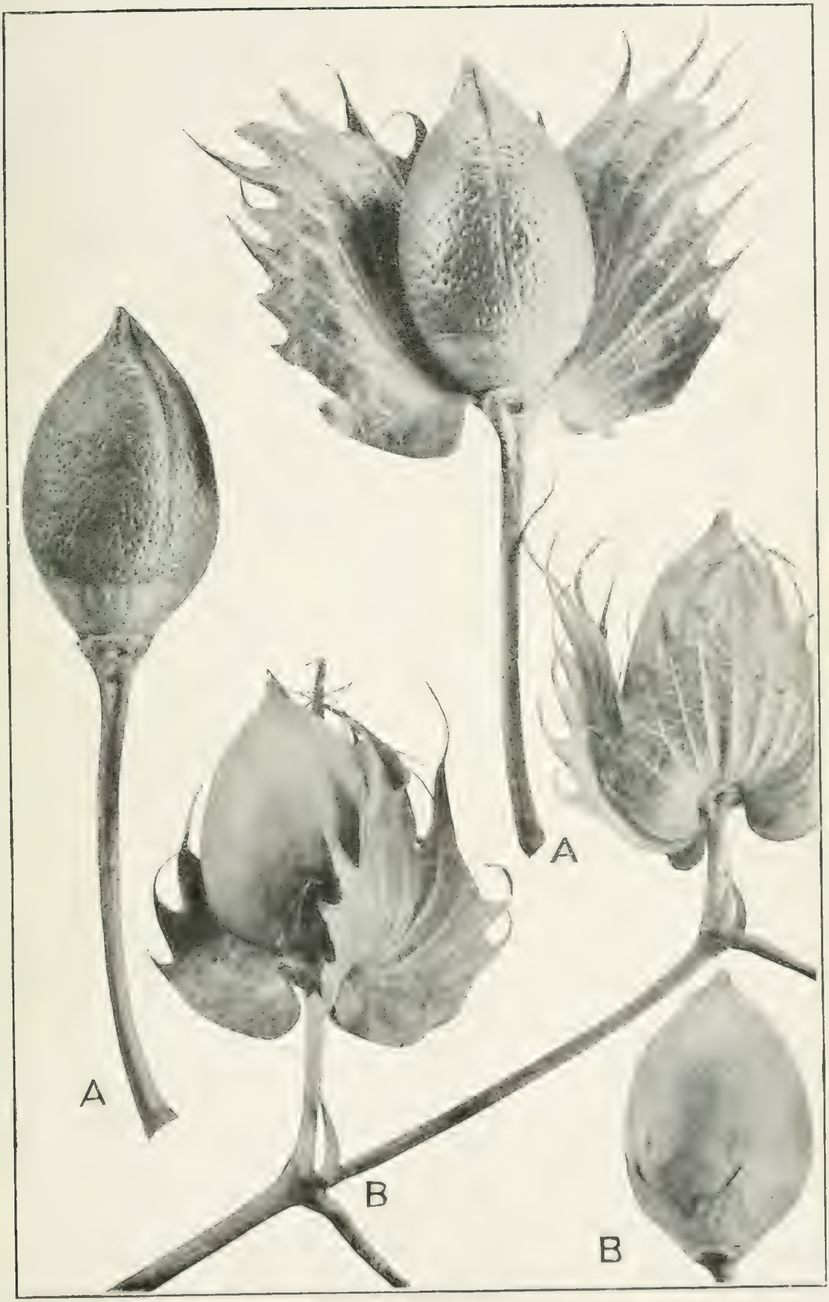

BOLLS OF COTTON: A, EGYPTIAN; B, HINDI.

(Natural size.)

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